CHAPTER 3
Air Quality

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Air quality conditions in the Lake Tahoe Region can affect human health, visibility, forest health, and Regional lake water quality, including the famed clarity of Lake Tahoe. The primary factors known to influence the Basin's air quality are motor vehicle emissions, vehicle entrainment of road dust, wildfire, residential wood smoke, topography, meteorology, and pollutants transported from sources outside the Region (Green et al. 2011; Chen et al. 2011; Zhu et al. 2011; Zhu et al. 2009; Gertler et al. 2008, Gertler et al. 2006; Cliff and Cahill 2000). Attainment of state, federal and TRPA Air Quality Threshold Standards represent conditions that reflect the public's values for protecting human and environmental health. Achievement of Air Quality Threshold Standards provides could also provide partial evidence that the *Regional Plan* and associated programs, and state and federal air quality regulations and programs are effective at improving air quality in the Region.

This chapter provides an evaluation of current air quality conditions and trends[1] in air pollutants relative to adopted Air Quality Threshold Standards and applicable state and federal air quality standards. It also assesses indicators related to factors (e.g., traffic volume) that potentially influence air pollutant concentrations. Pursuant to TRPA Resolution 82-11, TRPA has adopted Threshold Standards for carbon monoxide, ozone, visibility (atmospheric haze), nitrate deposition and odor. National Ambient Air Quality Standards (NAAQS) addressed in this evaluation fulfill requirements of the *Bi-State Compact* to measure and address the status of compliance with state and federal standards, and in part, requirements of California Air Resources Board (Mulford-Carrell Act) and the Federal Clean Air Act (40 CFR part 50). For air quality Threshold Standards, this evaluation addresses the status of several Numerical Standards, Management Standards with numerical targets, and one Policy Statement (Table 3-1). Past Threshold Evaluations have assigned Air Quality Threshold

[1] *Note: The trend analysis for all air quality pollutants in this chapter is based on the Theil regression used in U.S. EPA's IMPROVE monitoring program. This method is less susceptible to skewing by a small number of unusual values than simple linear regression. The Theil regression provides a quantitative understanding of trends over time by computing the median slope of the dataset, based on each possible pair of values. Numeric results of the Theil regression include (1) median slope, (2) S-value and (3) P-value. The median slope is calculated from all pairwise slopes (e.g. ozone concentration for year 1 and year 2 is one pairwise slope, concentration for year 1 and year 3 is another pairwise slope). The S-value is an intermediate value in the Kendal tau equation; it is the number of positive pairwise slopes minus the number of negative pairwise slopes based on the entire set of paired values. The sum (S) divided by the number of possible pairs (the Kendall tau statistic) was used to determine the probability that the differences occurred by chance. The P-value was used to determine statistical significance and confidence in the trend determination (e.g. P-value <0.05 for High confidence, >0.05 and <0.50 for Medium confidence, and >0.50 for Low confidence).*

Standards to eight “Threshold Indicators," including Carbon Monoxide (CO), Ozone (O_3), Particulate Matter (PM_{10} and $PM_{2.5}$), Visibility, US Highway 50 Traffic Volume, Wood Smoke, Vehicle Miles Traveled (VMT) and Atmospheric Nutrient Loading. This assessment addressed the same Threshold Standards as in past evaluations. However, Threshold Standards were organized into the Indicator Reporting Categories adopted in TRPA Resolution 82-11, and include: Carbon Monoxide, Ozone, Visibility (Regional and Sub-regional), Nitrate Deposition, and Odor (Table 3-1).

Regional Air Quality Conditions as Measured by the EPA Air Quality Index.
The US Environmental Protection Agency (EPA) Air Quality Index (AQI) is an indicator used for reporting daily air quality conditions in a Region; it is widely used by local air quality agencies in larger communities to communicate air quality conditions. There are no Threshold Standards, or state or federal standards associated with AQI. Instead, the AQI is used to signify the level or rating of health concern resulting from elevated air pollutant concentrations for an area. For each air pollutant a rating is provide that ranges from Good to Hazardous and is based on the highest pollutant concentration that is measured that day. For example, if ozone, particulate matter and sulfur dioxide are measured in area and ozone is measured at the highest concentration that day, ozone is used to calculate the AQI. The EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. Not all of these pollutants are measured in every area – often times an AQI is only reflective of one or two measured pollutants. The AQI uses pollutant-specific equations based on the highest concentration recorded for the calendar day to produce a unique number on a scale of 0 to 500. That number is then compared to ranges of values related to each level of concern (i.e., 0-50 = “Good”, 51-100 = “Moderate”, 101-150 = “Unhealthy of Sensitive Group”, 151-200 = “Unhealthy”, 201-300 = “Very Unhealthy”, 301 – 500 = “Hazardous”). An AQI of 100 or less generally corresponds to a concentration equal or better than the National Ambient Air Quality Standard (NAAQS) for that pollutant. Consequently, AQI values below 100 are generally believed to be satisfactory by EPA, while values above 100 are considered to be unhealthy for certain sensitive groups of people, then for all groups of people as values exceed 150.

One way of summarizing air quality for a year within a Region is to report the number of days with an AQI in each level of concern category (Table 3-2). For the Lake Tahoe Region, daily air quality data were available for PM_{10} (Sandy Way), carbon monoxide (Harvey’s Hotel), and ozone (Incline Village and South Lake Tahoe Airport) from which daily pollutant specific AQI categories were determined. Table 3-1 shows, based on available data, that the number of days rated as “good” has increased for the time period between 2007 (319 day) to 2011 (361 days), with a concurrent decrease in “moderate” days (from 46 days in 2007 to 4 in 2011). Overall, the AQI calculated for the Lake Tahoe area suggests that air quality conditions have improved since 2007, with no days rated as “Unhealthy for Sensitive Groups” recorded since 2008 – and no days ever recorded for the “unhealthy” to “hazardous” categories between 2007 and 2011. It should be noted however that due to the intermittent collection of data, the comparison between years could be confounded. The Incline Village monitoring station monitors ozone year-round, but was not operational in 2007 and part of 2008 (until May 15). At the South Lake Tahoe Airport site ozone monitoring was only conducted from May through October. This leaves no ozone monitoring data in the Lake Tahoe Basin from January 1, 2007 through May 6, 2007 and November 1, 2007- May 1, 2008. As ozone concentrations are generally higher in summer than winter, distributions of ozone concentrations by year will be shifted toward lower values for years with both winter and summer values and toward higher values for years with summer data only.

Table 3-1. *TRPA Threshold Standards and state and federal air quality standards addressed for Tahoe regional air quality.*

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
Carbon Monoxide (CO)	8-hour Carbon Monoxide	Numerical	Maintain carbon monoxide concentrations at or below 9 parts per million averaged over 8 hours, provided that each state shall review and certify to TRPA by February 28, 1983, as to what their carbon monoxide standards are as of that date, and this TRPA threshold standard shall be changed effective February 28, 1983, if necessary, to be the applicable state carbon monoxide standard applicable to the respective portions of the region in accordance with Article V (d) of the Compact.	**Carbon Monoxide 8-hour Average** California and Nevada: 6 ppm not to be exceeded. Federal 9 ppm – not to be exceeded more than once per year.	First and second highest CO concentration measured at Stateline, NV monitoring station	Parts Per Million (ppm)
	1-hour Carbon Monoxide	Numerical (State Standard)	No Adopted Standard	**Carbon Monoxide 1-hour Average** California: 20 ppm not to exceed. Federal and Nevada: 35 ppm, not to be exceeded more than once per year.	Highest CO concentration measured at Stateline, NV monitoring station	Parts Per Million (ppm)
	Winter Traffic Volume	Management (With Numerical Target)	Reduce traffic volumes on the U.S. 50 Corridor by 7 percent during the winter from the 1981 base year between 4:00 p.m. and 12:00 midnight, provided that those traffic volumes shall be amended as necessary to meet the respective state standards.	No Adopted Standard	Percent increase/decrease from 1981 winter (December through March) traffic volumes enumerated on Highway 50 at Park Avenue	Percent (%)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
Ozone (O_3)	1-hour Ozone	Numerical	Maintain ozone concentrations at or below 0.08 parts per million averaged over 1 hour.	**Ozone 1-hour Average** California: 0.09 ppm not to be exceeded Nevada: 0.10 ppm, not to be exceeded Federal: 0.12 ppm, 3-year average of the fourth-highest daily maximum must not be exceed concentration standard.	Highest 1-hour average ozone concentration measured within a year at any monitoring station	Parts Per Million (ppm)
	8-hour Ozone	Numerical (State Standard)	No Adopted Standard	**8-hour Average** California: 0.070 ppm, not to exceed. Nevada: no adopted standard Federal: 0.075 ppm, 3-year average of the fourth-highest daily maximum must not be exceed concentration standard.	Highest 8-hour average ozone concentration measured within a year at any monitoring station	Parts Per Million (ppm)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
	Oxides of Nitrogen	Numerical	Maintain oxides of nitrogen (NO_x) emissions at or below the 1981 level.	**Nitrogen Dioxide Annual Average** Nevada and Federal: 53ppb, not to exceed. California: 30ppb, not to exceed. **Nitrogen Dioxide 1-hour Average** Federal: 100 ppb, 3-year average of the 98th percentile of the daily maximum 1-hour average must not exceeded California: 18ppb, not to exceed.	**Nitrogen Dioxide Annual Average** Highest annual average concentration of NO_x and NO_2 **Nitrogen Dioxide 1-hour Average** Federal: 3-year average of the 98th percentile of the daily maximum 1-hour average of NO_2 California: Highest 1-hour concentration measured within an year at any site	Parts Per Billion (ppb)
Visibility	Respirable Particulate Matter (PM_{10})	Numerical	No Adopted Standard	**PM_{10} 24-Hour Average** Federal: 150 $\mu g/m^3$ (24-hr mean, three yrs. running) California: 50 $\mu g/m^3$ **PM_{10} Annual Mean** Federal: 50 $\mu g/m^3$ (ann. avg., three yrs. running) California: 20 $\mu g/m^3$ (ann. avg)	**PM_{10} 24-Hour Average** Number of 24-hr periods exceeding the applicable federal or state standards at any monitoring station **PM_{10} Annual Mean** Annual average PM_{10} concentrations at any permanent monitoring station ($\mu g/m^3$)	Micrograms per cubic meter ($\mu g/m^3$)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
	Fine Particulate Matter ($PM_{2.5}$)	Numerical	No Adopted Standard	**$PM_{2.5}$ 24-Hour Average** Federal: 35 $\mu g/m^3$, 3-year average of the 98th percentile of 24-hour concentration must not exceed concentration standard California: No Adopted Standard Nevada: No Adopted Standard **$PM_{2.5}$ Annual Arithmetic Mean** Federal: 15 $\mu g/m^3$, 3-year average of weighted annual mean concentration must not exceed. California: 12 $\mu g/m^3$ Annual concentration must not exceed Nevada: No Adopted Standard	**$PM_{2.5}$ 24-Hour Average** Number of 24-hr periods exceeding the applicable federal or state standards at any monitoring station ($\mu g/m^3$) **$PM_{2.5}$ Annual Arithmetic Mean** Annual average $PM_{2.5}$ concentrations at any permanent monitoring station ($\mu g/m^3$)	Micrograms per cubic meter ($\mu g/m^3$)
	Wood Smoke	Numerical	Reduce wood smoke emissions by 15% of the 1981 base values through technology, management practices and educational programs.	No Adopted Standard	Same as PM (above)	Same as PM (above)
	Suspended Soil Particles	Numerical	Reduce suspended soil particles by 30% of the 1981 base values through technology, management practices and educational programs.	No Adopted Standard	Same as PM (above)	Same as PM (above)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
	Regional Visibility	Numerical	Achieve an extinction coefficient of 25 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 156 km, 97 miles); Achieve an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 115 km, 71 miles). Calculations will be made on three year running periods using the existing 1991-1993 monitoring data as the performance standards to be met or exceeded.	**Visibility Reducing Particles** California: Extinction coefficient of 0.07 per kilometer – visibility of 30 miles or more due to particles when relative humidity is less than 70%.	Extinction coefficient and distance of visibility. 3-year running average of Extinction coefficient.	Light extinction (Mm^{-1}) and Miles or Kilometers
	Sub-Regional Visibility	Numerical	Achieve an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 78 km, 48 miles); Achieve an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 31 km, 19 miles).	No Adopted Standard	Extinction coefficient and distance of visibility. 3-year running average of Extinction coefficient.	Light extinction (Mm^{-1}) and Miles or Kilometers

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
	Vehicle Mile Traveled	Numerical	Reduce vehicle miles of travel in the Basin by 10% of the 1981 base year values (10% reduction is equal to 2,067,568 VMT, on peak summer day). For the 2011 Threshold Evaluation, 1981 VMT has been scaled to be comparable with the most recent model outputs. See VMT discussion below for detailed explanation.	No Adopted Standard	Percent increase/decrease in vehicle miles travel back-casted from 2010 levels. Estimated VMT based on the relationship between 2010 peak traffic volume and modeled VMT (Source: TRPA TransCAD Model)	Vehicle Miles Traveled (VMT) and Percent (%)
Nitrate Deposition	Nitrate Deposition	Management	Reduce the transport of nitrates into the Basin and reduce oxides of nitrogen (NOx) produced in the Basin consistent with the water quality thresholds.	No Adopted Standard	Implementation of management standard into the Regional Plan	N/A
Odor	Odor	Policy Statement	It is the policy of the TRPA Governing Board in the development of the Regional Plan to reduce fumes from diesel engines to the extent possible.	No Adopted Standard	Implementation of policy statement into the Regional Plan	N/A

Information Sources: *Federal Standards: http://www.epa.gov/air/criteria.html; California Standards: http://www.arb.ca.gov/research/aaqs/aaqs2.pdf;*
Nevada Standards: http://ndep.nv.gov/baqp/monitoring/docs/445b391.pdf: TRPA Threshold Standards: http://www.trpa.org/documents/docdwnlds/goals.pdf (Attachment C)

Table 3-2. Number of days in each AQI category by year, 2007-2011

Year	Good	Moderate	Unhealthy for sensitive groups	Unhealthy	Very Unhealthy	Hazardous
2007	319	46	0	0	0	0
2008	332	32	2[2]	0	0	0
2009	342	23	0	0	0	0
2010	344	21	0	0	0	0
2011	361	4	0	0	0	0

Air Quality Data Sources

The data source used to compare air pollutant concentrations to the established Threshold Standard in this chapter were from the EPA Air Quality System (AQS) (http://www.epa.gov/ttn/airs/airsaqs/). The AQS contains ambient air pollution data collected by EPA, state, local, and tribal air pollution control agencies. The AQS data was obtained using the AQS data mart (http://www.epa.gov/ttn/airs/aqsdatamart/). Data for comparison with the threshold indicators was taken from annual summaries for sites when available, otherwise the values of threshold indicators were computed from the raw data option in the AQS data mart. Summary indicators were sometimes computed using data from the California Air Resources Board iADAM website (http://www.arb.ca.gov/adam/index.html) and from data supplied by the Washoe County Health District, Air Quality Management Division.

Data limitations

Three factors affect the ability to comprehensively evaluate the status and trends of air quality indicators in the Lake Tahoe Basin: 1) lack of spatial coverage of monitoring sites, 2) lack of long-term operations of monitors at a given site, and 3) the nature of existing indicators used to evaluate air quality in the Region. In general, the spacing and density of monitoring sites is insufficient to know the extent of how maximum and minimum pollutant concentrations are distributed throughout the basin. This is particularly true for ozone and $PM_{2.5}$ for which it is unknown if the current network has tracked maximum (and minimum) pollutant concentrations in the Region.

Many monitoring sites have been operated only intermittently or have been shut down after a few years (except for the Stateline, NV carbon monoxide monitoring site and the Bliss visibility monitoring site). Locations of monitoring sites have also been changed, making it more difficult to determine with a high degree of certainty whether a trend was due to a real change in the atmosphere or more a result of the site change. This situation is accounted for by reducing the confidence rating for a given status and trend determination as noted in Indicator Summaries.

The indicators presented here are related to state, federal and TRPA standards. In most instances, each indicator only takes into account the highest recorded measurement (e.g. highest, second highest) and do not take into account the distribution of measurements throughout a given year. As a consequence, these indicators do not provide complete characterization of the range of conditions that occur and how they vary within a year. Thus, the measurements could be significantly better than the standard most of the year, but one high measurement could cause the status determination for that year to be

[2] Corresponds to increased wildfire activity - statewide

worse than the standard. The EPA AQI information (Table 3-1, above) has been included to provide a characterization of the “within year” air quality conditions.

These data limitations are being addressed by TRPA. With time, TRPA in partnership with state and county air quality authorities is working to increase the spatial coverage and robustness of air quality monitoring data for the Region.

Carbon Monoxide

Carbon monoxide (CO) is a tasteless, odorless, and colorless gas. It is a public health concern because elevated concentrations affect human and animal health by reducing the supply of oxygen to body tissues. This can result in shortness of breath, seizures, coma, or even death. Carbon monoxide is created through the incomplete combustion of carbon-based fuels. The primary anthropogenic sources of CO are on-road motor vehicles (30%), residential wood burning (28%), motorized watercraft (16%), and off-highway vehicles (8%) (CARB 2006). Wildfires are a natural source of CO. Meteorology also plays a key role in influencing the concentration of CO within the Region as wind and inversion layers can effect CO concentrations.

Policy and management actions implemented through the *Regional Plan* to control CO emissions focus on reducing private automobile use through improvements to public transportation and bike trail infrastructure. Vehicle emission standards enacted by state and federal governments have also contributed to reductions in CO emissions in the Region, mainly by motivating improvements in engine and exhaust technologies. State air quality agencies regulate the timing and magnitude of forest biomass prescribed burning or pile burning.[3]

The status and trends of three indicators were evaluated to characterize the overall status and trend of the Carbon Monoxide Indicator Reporting Category, including 1-hour and 8-hour CO standards, and winter traffic volume. Following this introduction for Carbon Monoxide are Indicator Summaries that provide a more detailed evaluation of each indicator, relative to adopted Threshold Standards. In general, indicators for each of the Carbon Monoxide Threshold Standards show that the status is considerably better than the established Threshold Standards. The trend is moderately or rapidly improving, and confidence in the determination of status and trend is moderate to high (Figure 3-1). Consequently, the overall status for the Carbon Monoxide Indicator Reporting Category was characterized to be “considerably better than target,” with “rapid improvement,” and a confidence rating of “high,” based on the indicator aggregation system used in this evaluation (Figure 3-1). Past evaluations would have characterized the status of this Indicator Reporting Category as “attainment” with a “positive” trend, with no determination of confidence level.

[3] http://www.arb.ca.gov/smp/progdev/pubeduc/pbfs.pdf

Overall Status and Trend of the Carbon Monoxide Indicator Reporting Category

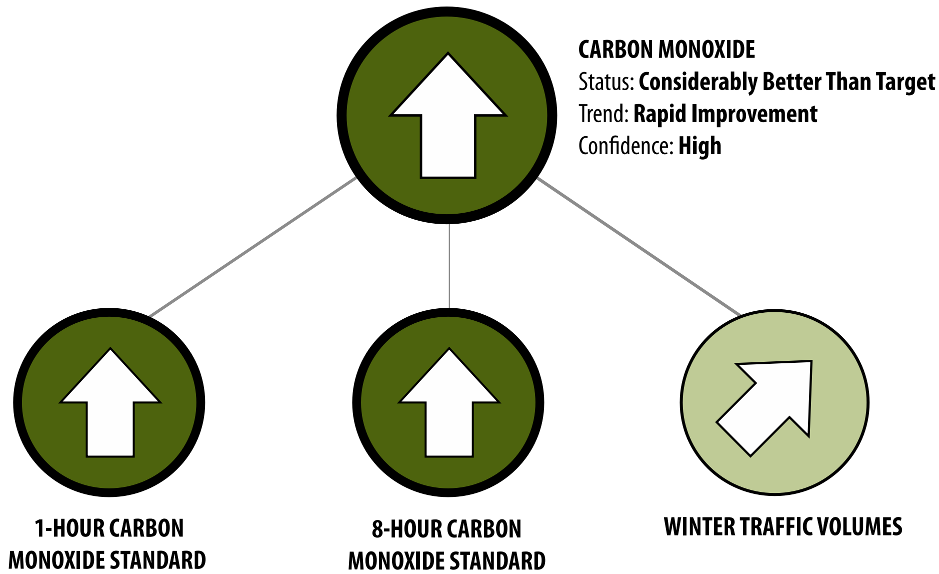


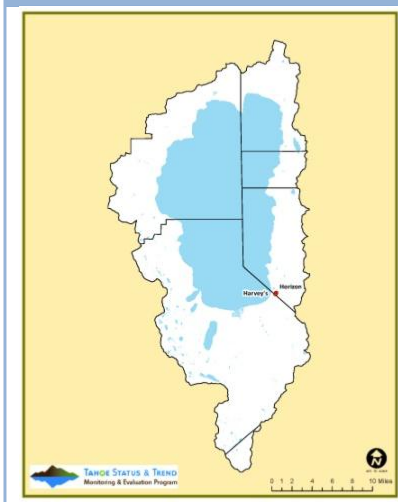
Figure 3-1. *Reporting icons for the three indicators evaluated in the Carbon Monoxide Indicator Reporting Category. Results from each of the three indicators (bottom) were evaluated and aggregated to characterize the overall status of the Carbon Monoxide Indicator Category (top).*

Carbon Monoxide: **Highest and 2nd Highest 1-Hour Concentration of Carbon Monoxide**

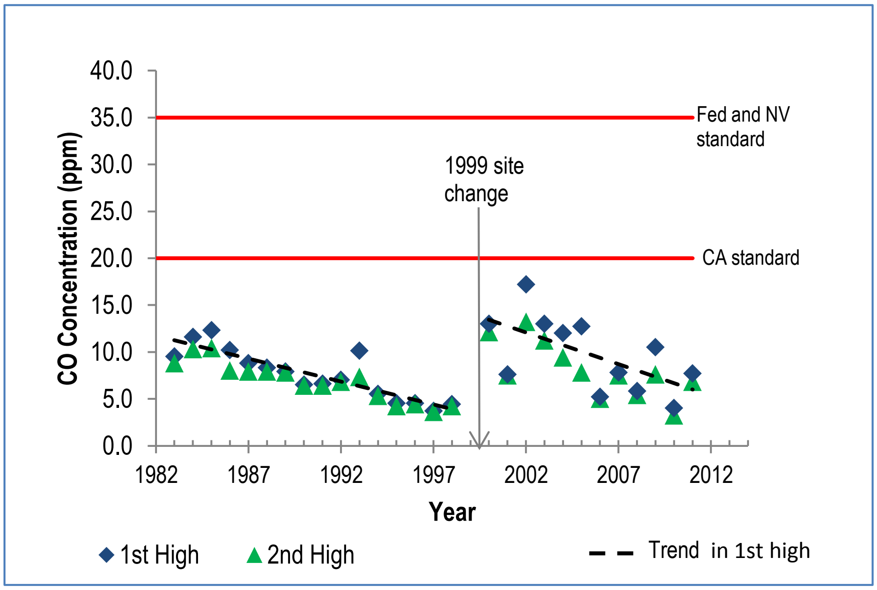
Reporting Icon	Trend

1-HOUR CARBON MONOXIDE STANDARD
Status: **Considerably Better than Target**
Trend: **Rapid Improvement**
Confidence: **High**

Map



Carbon Monoxide monitoring sites located at Horizon and Harvey's Casino in the Lake Tahoe Basin.



The highest and second highest 1-hour-average carbon monoxide (CO) concentrations relative to adopted Threshold Standards from the year 1983 through 2011 at the Stateline monitoring sites. All values are better than the federal and state standards shown as red lines. Long-term trends show rapid improvement from 1983-1998, and 2000-2011. Discontinuity in the data occurred in 1999 due to relocation of the monitoring site. Data Source: Nevada Division of Environmental Protection (NDEP).

Data Evaluation and Interpretation

Relevance - Carbon monoxide (CO) in high concentrations affects human health by reducing the supply of oxygen to the tissues of the body. Health effects can include headaches, nausea, reduced mental alertness, and even death at very high concentrations. Federal and state standards, with varying time-averaging periods, have been adopted to protect the public from this pollutant. This indicator addresses the highest and second highest monitored CO concentrations averaged over every 1 hour for the calendar year.
Threshold Category – Air Quality
Indicator Category – Carbon Monoxide
Adopted Standards – California standard: Maintain 1-hour concentrations of carbon monoxide at or below 20 ppm, Nevada and federal standard: Maintain 1-hour concentrations of carbon monoxide below 35 ppm, TRPA has not adopted a 1-hour carbon monoxide Threshold Standard.
Type of Standard - Numerical
Indicator (Unit of Measure) – Highest and second highest 1-hour concentration in parts per million (ppm) of carbon monoxide measured within a calendar year. Only the highest 1-hour concentration is used to determine compliance with adopted Threshold Standards. The 2nd highest is provided to demonstrate the magnitude of difference between the highest and 2nd highest recorded 1-hour concentration in the Region.
Status – The Region has been in compliance with the strictest adopted Threshold Standard since 1983, including 2011. The 2011 first high and second high 1 hr. carbon monoxide (CO) concentration values were 7.7 ppm and 6.8 ppm respectively (EPA 2011a). The first

high value is 39% of the most stringent (CA) standard, of not to equal, or exceed 20 ppm. The second high value is slightly more than 19% of the federal and NV standards of 35 ppm. A status of "considerably better than target" was designated.

Trend – Trend was calculated using the Theil regression method (Theil 1950). **Long-Term Trend -** The long-term trend indicates a reduction in highest recorded 1-hour average CO concentrations at the Horizon site between 1983 and 1998, and the Harvey's site between 2000 and 2011. On average, 1-hour CO concentrations have decreased by -0.5 ppm/year at the Horizon site and -0.7 ppm/year at the Harvey's site. These rates are -2.5% per year and -3.5% per year of the most stringent (CA) standard of 20ppm, respectively. Consequently, the long-term trend determination is "rapid improvement." **5-Year Trend** - The trend over the most recent 5 years (2007-2011) is not consistent with the long-term trend and instead indicates "moderate improvement" in the highest 1-hour average CO concentrations (-1%). This indicator has been in attainment with the strictest 1-hour average CO concentration standard since monitoring efforts began in 1983.

Confidence

Status - There is "high" confidence in the condition status because the data were collected using federal reference methods (EPA 2011b), are subject to quality assurance requirements, and were collected consistently between 1983 and 2010 with the exception of moving the monitoring site approximately ¼ mile in 1999. Only one monitoring site is used to determine indicator status. However, the monitoring site is located at the south shore casino core which represents the greatest volume of vehicle traffic in the Region, and consequently the measurements are thought to represent the highest source of CO emissions (i.e., worst case scenario).

Long-Term Trend - The confidence in the trend for the first high values at the Horizon site is "high" for the long range analysis of 16 data points with a confidence level of 100%, an S-value of -89 and a $P < 0.01$. The confidence in the trend for the first high values at the Harvey's site is also "high" for 12 data points with a confidence level of 98%, an S-value of -31 and a P value of 0.02.

5-Year Trend - The confidence in the trend for first high over the most recent 5 years (2007-2011) is "moderate" with a confidence level of 59%, an S value of -2 and a P value of 0.41. The "moderate" confidence determination is the result of few data points (n=5) and inter-annual variation in 1-hour concentrations.

Overall Confidence - The overall confidence is "high" because there is "high" confidence in the condition status and long-term trends. Although there is "moderate" confidence in the short-term trend, data for the last five years indicate 1-hour CO concentration have remained well below the strictest standard.

Interim Target - The Region is currently in attainment with this standard, and therefore it is not necessary to establish an interim target.

Target Attainment Date - The Region is currently in attainment with this standard, and therefore it is not necessary to identify a target attainment date

Human and Environmental Drivers - Carbon monoxide is emitted from incomplete fuel combustion by sources such as cars, trucks, boats, construction equipment, fireplaces, woodstoves, furnaces and wildfire. The ambient concentration of CO is also dependent on meteorological conditions such as temperature, wind speed and atmospheric mixing conditions.

Monitoring Approach – Between 1983 and 1998, carbon monoxide was monitored at the Horizon Hotel in Stateline, NV. In 1999, the monitoring site was relocated to Harvey's Resort parking garage in Stateline, NV. The site is located to monitor the highest CO concentrations in the Lake Tahoe Basin because historically this area received the high vehicle traffic volume (NDOT and Caltrans, and is intended to be representative of both the CA and NV sides of the south shore resort district. Data are collected, analyzed and reported by the Nevada Division of Environmental Protection (NDEP 2011).

Monitoring Partners – Nevada Division of Environmental Protection (NDEP), U.S. Environmental Protection Agency (EPA), and Tahoe Regional Planning Agency. It is important to note that the NDEP has petitioned the EPA to remove the Stateline, NV monitoring site because of the continued compliance with established CO concentration standards. The EPA has approved the removal of the monitoring site and consequently, data from this site will no longer be available in future measurements of CO concentrations.

Programs and Actions Implemented to Improve Conditions - Public transit operations (e.g., free skier shuttle service, BlueGo, Tahoe Area Rapid Transit), state and federal vehicle emission standards, intersection improvements, bicycle trail infrastructure improvements and the Heavenly Gondola Project.

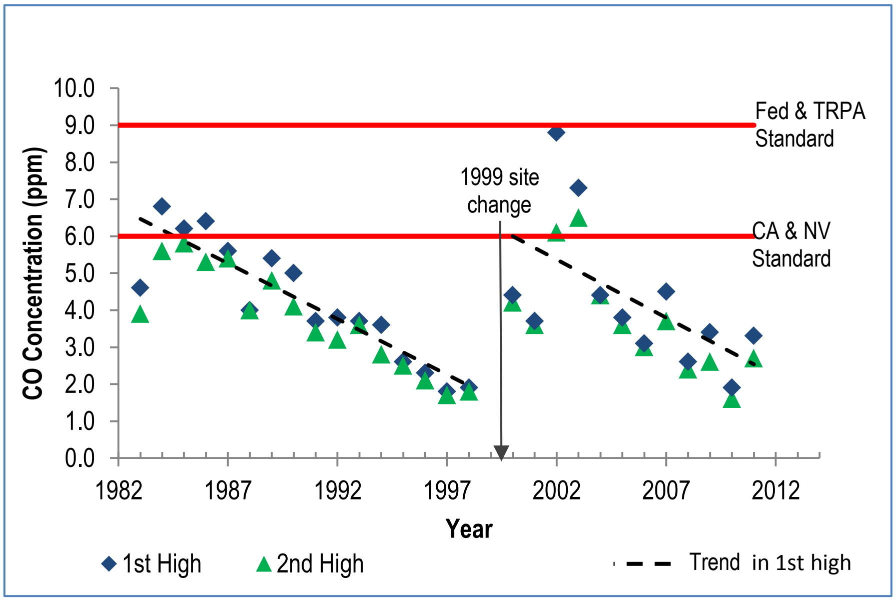
Effectiveness of Programs and Actions - Current CO status and trends suggest TRPA, state, and federal actions to reduce CO emissions and decrease traffic volumes are effective at reducing 1-hour CO concentrations at this location.

Recommendations for Additional Actions – Continue existing policies, programs and actions. Additional landuse policy incentives to facilitate improved walkability and bike-ability of urban areas may further reduce air pollution loads.

Carbon Monoxide: **Highest and 2nd Highest 8-hour Average Concentrations of Carbon Monoxide**

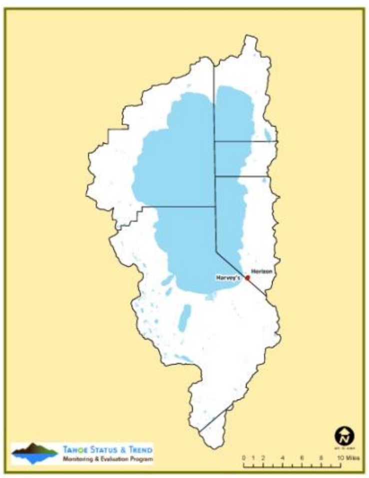
Reporting Icon	Trend

8-HOUR CARBON MONOXIDE STANDARD
Status: **Considerably Better Than Target**
Trend: **Rapid Improvement**
Confidence: **High**



The highest and second highest 8-hour average carbon monoxide (CO) concentration relative to adopted standards from the year 1983 through 2011 at the Stateline monitoring sites. All concentrations are better than federal standards and most are better than the more stringent TRPA and state standards. The long-term trends show rapid improvement from 1983-1998 and 2000-2011. Discontinuity in data occurred in 1999 due to relocation of the monitoring site. Data Source: Nevada Division of Environmental Protection.

Map



Carbon Monoxide monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – Carbon monoxide (CO) in high concentrations affects human health by reducing the supply of oxygen to the tissues of the body. Health effects can include headaches, nausea, reduced mental alertness and even death, at very high concentrations. TRPA, federal and state standards have been adopted to protect the public from this harmful pollutant. This indicator addresses the highest and second highest monitored CO concentrations averaged over every 8 hours for the calendar year.

Threshold Category – Air Quality

Threshold Indicator Category – Carbon Monoxide

Adopted Standards – TRPA: Highest 8-hour average of 9 ppm – not to be exceeded, California and Nevada: Highest 8-hour average of 6 ppm is not to be exceeded, Federal: Highest 8-hour average of 9 ppm – not to be exceeded more than once per year.

Type of Standard – Numerical

Indicator (Unit of Measure) - First and second highest 8-hour CO concentration (ppm). Only the highest 8-hour concentration is used to determine compliance with adopted standards. The 2nd highest is provided to demonstrate the magnitude of difference between the highest and 2nd highest recorded 1-hour concentration in the Region.

Status – The Region has been in compliance with the strictest 8-hour CO standard since 2003. The 2010 1st highest and 2nd highest 8-hour average carbon monoxide (CO) concentration values were 3.3 ppm and 2.7 ppm respectively (EPA 2011a). The highest 8-hour average concentration is equal to 55% of the most stringent (CA and NV) standard of 6 ppm (45% below standard).

The 2nd high value is equal to 45% of the most stringent standard of 6 ppm (55% below standard). Consequently, the status was determined to be "considerably better than target."

Trend – Trend was calculated using the Theil regression method (Theil 1950). **Long-term Trend –** The long-term trend indicates a decreasing highest 8-hour average CO concentration at the Horizon site between 1983 and 1998, and at the Harvey's site between 2000 and 2011. The trend represents a change in concentration of -0.4 ppm/year at both the Horizon and Harvey's sites. These rates are -6.7% per year of the most stringent (CA and NV) standard of 6 ppm, so the long-term trend designation is "rapid improvement." **Five-Year Trend –** The trend over the most recent 5 years (2007-2011) is consistent with the long-term trend, and indicates decreasing first high 8-hour average CO concentrations. The regression analysis of the last 5 years of data indicated a -0.3 ppm/year reduction in CO concentration.

Confidence –

Status – Only one monitoring site is used to determine indicator status. However, the monitoring site is located at the south shore casino core which represents the greatest annual volume of vehicle traffic in the Region (according to Caltrans and NDOT traffic volume data), and consequently the measurements are thought to represent the highest source of CO emissions in the Region (i.e., worst case scenario). There is "high" confidence in the condition status, because the data collected (using federal reference methods (EPA 2011b)) are subject to quality assurance requirements, and were collected continuously between 1983 and 2010 (except 1999).

Long-term Trend – The confidence in the trend for the first high 8-hour average values at the Horizon site is "high" for the long range analysis of 16 data points, with a confidence level of 100%, an S-value of -97, and a P value of <0.01. The confidence in the trend for the 1st highest values at the Harvey's site is also "high" for 12 data points, with a confidence level of 98%, an S-value of -33, and a P value of 0.02.

Five-Year Trend – The confidence in the trend for the 1st high over the most recent 5 years (2007-2011), is "moderate" with a confidence level of 76%, an S-value of -4, and a P = 0.24.

Overall Confidence – The overall confidence in the status and trend determination is "high" because there is "high" confidence in the status and long-term trend. Although confidence in the short-term trend is only "moderate," data for the last five years indicates 8-hour CO concentrations are well below the strictest standard.

Interim Target – The Region is currently in attainment with this standard, and therefore it is not necessary to establish an interim target.

Target Attainment Date – The Region is currently in attainment with this standard, and therefore, it is not necessary to establish a target attainment date.

Human & Environmental Drivers – Carbon monoxide is emitted from incomplete fuel combustion by sources such as cars, trucks, boats, construction equipment, fireplaces, woodstoves, furnaces, and wildfire. The ambient concentration of CO is highly dependent on meteorological conditions such as temperature, wind speed, and mixing conditions.

Monitoring Approach – Between 1983 and 1998, carbon monoxide was monitored at the Horizon Hotel in Stateline, NV. In 1998, the monitoring site was relocated to Harvey's Resort parking garage in Stateline, NV. The site was selected to monitor the highest CO concentrations at Lake Tahoe due the highest traffic volume recorded near the site, and is intended to be representative of both the CA and NV sides of the South Shore resort district. Data are collected, analyzed, and reported by the Nevada Division of Environmental Protection (NDEP 2011).

Monitoring Partners – Nevada Division of Environmental Protection (NDEP), U.S. Environmental Protection Agency (EPA), and Tahoe Regional Planning Agency. It is important to note that the NDEP has petitioned the EPA to remove the Stateline, NV monitoring site because of the continued compliance with established CO concentration standards. The EPA has approved the removal of the monitoring site and consequently, data from this site will no longer be available in future measurements of CO concentrations.

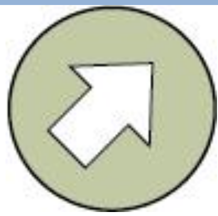
Programs and Actions Implemented to Improve Conditions – Public transit operations (e.g., free skier shuttle service, BlueGo, Tahoe Area Rapid Transit), state and federal vehicle emission standards, intersection improvements, bicycle trail infrastructure improvements, and Heavenly Gondola project.

Effectiveness of Programs and Actions – Current CO status and trends suggest actions to reduce CO concentrations (e.g., state and federal vehicle emission standards and reductions in traffic volumes are effective at reducing 8-hour CO concentrations.

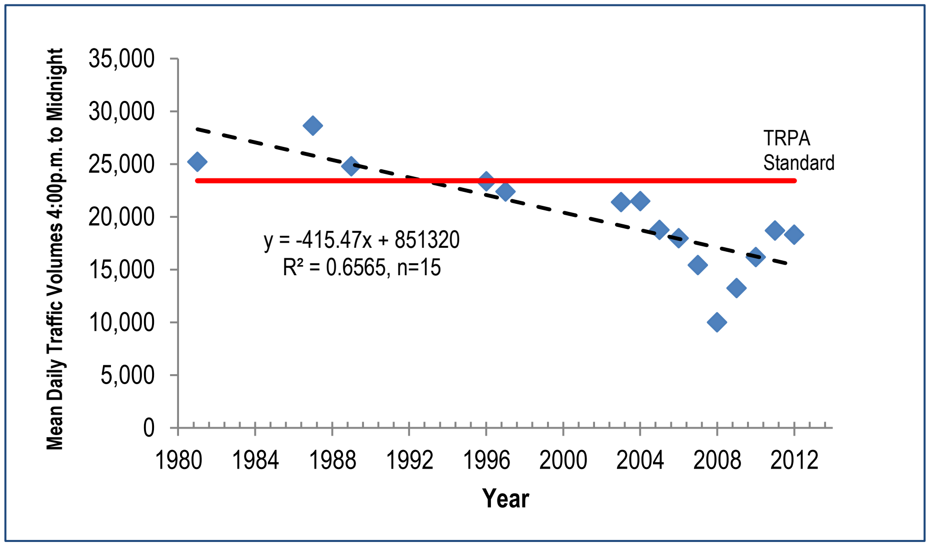
Recommendations for Additional Actions – Continue existing policies, programs and actions. Additional incentives to improve the walkability and bike-ability of urban areas may further reduce air pollutant loads.

Carbon Monoxide: **Average Daily Winter Traffic Volume, Presidents' Weekend**

Status & Trend	Trend



WINTER TRAFFIC VOLUMES
Status: **At or Somewhat Better Than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**



Trend in average daily winter traffic volume measured between 4 p.m. and Midnight (vehicles/day) on Presidents' Day Weekend at Highway 50 and Park Avenue, South Lake Tahoe, CA. 1981 to 2012. Note: data not collected for 1982-1986, 1990–1995, and 1998-2002 periods resulting in a decrease in confidence in trend determination. Data Source: Caltrans and TRPA.

Map

Location of traffic volume monitoring.

Data Evaluation and Interpretation

Relevance – This indicator measures traffic congestion levels during winter months and provides a proxy measure of carbon monoxide concentration levels according to TRPA Resolution 82-11.
Threshold Category – Air Quality
Threshold Indicator Category – Carbon Monoxide
Adopted Standards – TRPA: Reduce traffic volumes on the US Highway 50 Corridor by 7 % (equivalent to a reduction of 1,762 vehicles/day from 25,173 vehicles/day) during the winter, from the 1981 base year (standard is equivalent to 23,411), between 4:00 p.m. and 12:00 midnight, provided that those traffic volumes shall be amended, as necessary, to meet the respective state standards; State and Federal: no adopted standards.
Type of Standard – Management Standard with a numeric target.
Indicator (Unit of Measure) – Average daily traffic volumes measure at Park Avenue and Highway 50 between 4:00 p.m. and 12:00 midnight on Presidents' Day weekend (vehicles/day).
Status – Data from winter 2012 indicate that average daily traffic volume measured on Presidents' Day weekend was 18,294 or 22% lower than traffic volumes measured over Presidents' Day weekend in 1981. Consequently, the Region is "considerably better than the target" to reduce by 7% 1981 traffic volume levels (i.e., 23,411 vehicles/day).
Trend – The long-term trends were estimated with a least squares (simple) linear regression model and represents an overall average decrease in traffic volume of 416 vehicles/day/year between 1981 and 2012 (an overall improvement of 1.8%/year). This

level of annual improvement results in a trend determination of “moderate improvement.”

Pre and Post-Heavenly Gondola Project Comparison – Average winter traffic volumes and rate of traffic volume change were compared between dates prior to and after the Heavenly Gondola Project (2001) to reveal the potential effects of the project on traffic volume at Park Avenue and Highway 50. The average daily traffic volume pre-Heavenly gondola project was 24,854 vehicles/day, and post-project was on average 17,117 vehicles/day, representing an average reduction of 7,737 vehicles/day. Prior to the gondola project, average rate of traffic volume was decreased by 229 vehicles/day/year, compared to a post project rate decrease of 483 vehicles/day/year. This analysis suggests the Heavenly Gondola Project supported by the TRPA Regional Plan may have reduced overall winter traffic volumes, and resulted in a more rapid decline in traffic volumes than if the project had not been implemented.

Confidence –

Status – Traffic volume is continuously measured with an automated traffic counter at Park Avenue and Highway 50, and regularly calibrated according to protocols maintained by the California Department of Transportation (Caltrans; http://traffic-counts.dot.ca.gov/). There is “high” confidence in the current status determination (2012) because established protocols are used, data has been continuously collected since 2003, and current data is available.

Trend – There are several gaps in data collected from 1982-1986, 1990–1995, and 1998-2002 that resulted in reduced confidence in data presented prior to 2003 (that is, data was collected in 15 of the last 31 years). These data gaps along with an R^2 value of 0.66 reduce confidence in long-term trend to “moderate.”

Overall – The overall confidence in the status and trend is “moderate” because of the “moderate” confidence determination for trend.

Interim Target – The Region is currently in attainment with the Threshold Standard. Therefore, it is not necessary to establish an interim target.

Target Attainment Date – The Region is currently in attainment with the Threshold Standard. Therefore, it is not necessary to establish a target attainment date.

Human & Environmental Drivers – Several factors can influence traffic volumes measured on Presidents’ Day weekend, including weather, economy, and availability of alternative modes of transportation. In winter 2001/2002 Heavenly Resort improved its free skier shuttle services and installed a Gondola near the site where traffic volumes are measured. It is presumed that the availability of these alternative modes of transportation and the Gondola project contributed to the reduced traffic volumes to a level below the TRPA Threshold Standard.

Monitoring Approach – This indicator is measured by California Department of Transportation (Caltrans) continuously, using automated counters placed in the roadway at the intersection of Park Avenue and US Highway 50 (in South Lake Tahoe), including on Saturday of Presidents’ Day weekend from 4:00 p.m. and 12:00 midnight, coinciding with the historical period of the most frequent exceedance of California’s carbon monoxide (CO) standards. Data are summarized by Caltrans, and subsequently accessed by TRPA for reporting purposes.

Monitoring Partners – California Department of Transportation and TRPA.

Program and Action Implemented to Improve Conditions – Public transit operations (e.g., free skier shuttle service, BlueGo, Tahoe Area Rapid Transit), intersection improvements, improved walkability at environmental redevelopment at Stateline, and Heavenly Gondola project.

Effectiveness of Programs and Actions – Current traffic volume status and trends suggest actions to reduce traffic volumes in the Stateline area are effective.

Recommendations for Additional Actions – Continue existing policies, programs and actions. Additional incentives to improve the walkability and bike-ability of urban areas may further reduce air pollutant loads. The basis for this standard should be reviewed because at the time when this standard was adopted, the relationship between traffic volume and carbon monoxide was well understood. Since then, vehicle tail pipe pollution emissions have been substantially reduced, as a result of more stringent vehicle emission standards and “smog check” requirements. The question that needs to be addressed is whether this indicator continues to provide a good proxy measure of CO concentrations.

Ozone

Ozone (O_3) is created through a photochemical reaction between hydrocarbons, oxides of nitrogen, and sunlight. At high concentrations in the lower atmosphere (ground level), O_3 is an air pollutant that can cause harm to the respiratory systems of people and animals, and damage plant tissue. Young and elderly people are especially susceptible to elevated O_3 levels, which can cause lung and other respiratory illnesses. Ozone damages trees and plants, particularly ponderosa pines, Jeffrey pines, and quaking aspen, which make up a large portion of the Basin's tree population (Davis and Gerhold 1976).

Ground-level ozone is not directly emitted from typical pollutant sources like automobiles or industrial activities, but instead is created through a complex photochemical reaction between precursor gases (such as hydrocarbons and oxides of nitrogen), and sunlight in the lower atmosphere. The primary sources of the precursor gases in the Lake Tahoe air basin include on-road motor vehicles, residential fuel combustion, motorized watercraft, off-road equipment, solvent and fuel evaporation, and off-road recreational vehicles (CARB 2006). Ozone can also be transported into the Lake Tahoe air basin from outside sources, although these sources are reported to not substantially contribute to overall O_3 concentrations (CARB 2004). Research into the proportional magnitude of ozone transport from outside ozone sources is on-going. Because ozone formation is a photochemical process, higher concentrations are created on cloud-free summer days when the sun's radiation is at its peak.

The status and trends of four indicators were evaluated to characterize the overall status and trends of the Ozone Indicator Reporting Category, including highest 1-hour and 8-hour average O_3 indicators, the 3-year 4th highest 8-hour average O_3 indicator and modeled oxide on nitrogen (NO_x) indicator. Based on these indicators and as detailed in the Indicator Summaries below, the Region overall is at or somewhat better than the adopted Threshold Standards. Overall, the Basin can be characterized as "at or somewhat better than the standard," with "little or no change" in trend, with "moderate" confidence in the status and trend determination (Figure 3-2).

Overall Status and Trend of the Ozone Indicator Reporting Category

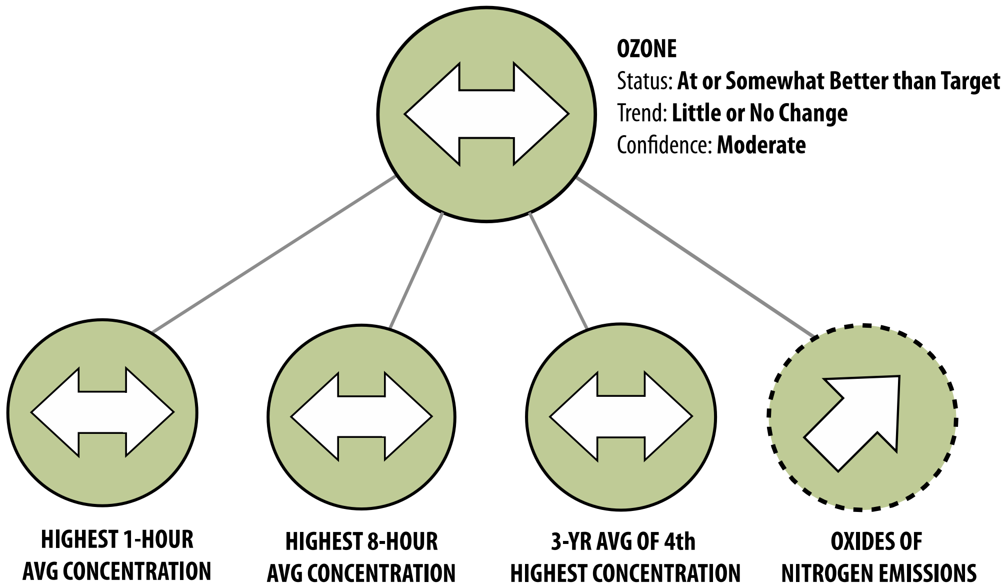
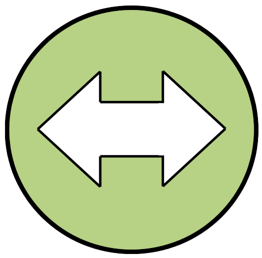


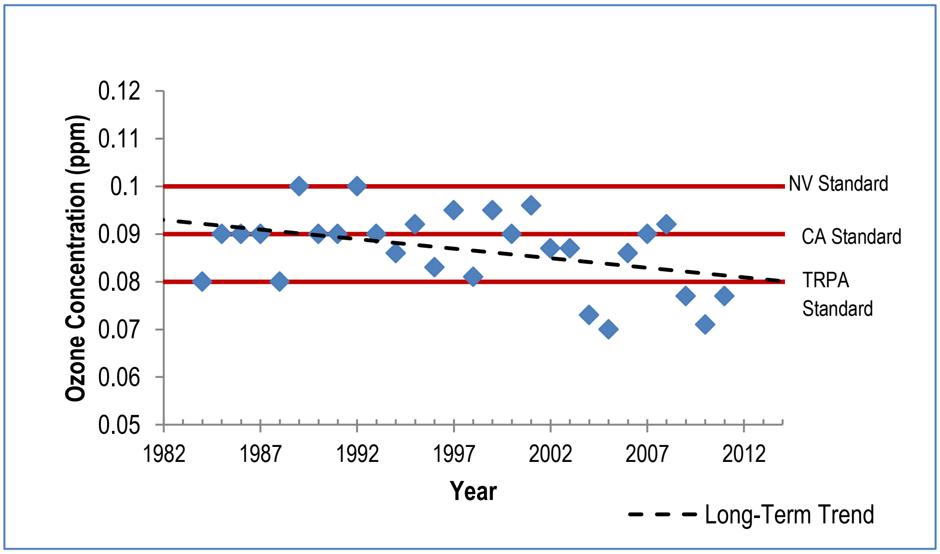
Figure 3-2. *Reporting icons for the four indicators evaluated in the Ozone Indicator Reporting Category. Results from each of the four indicators (bottom) were evaluated and aggregated to characterize the overall status of the Ozone Indicator Reporting Category (top).*

Ozone: **Highest 1-Hour Average Concentration of Ozone**

Reporting Icon	Trend

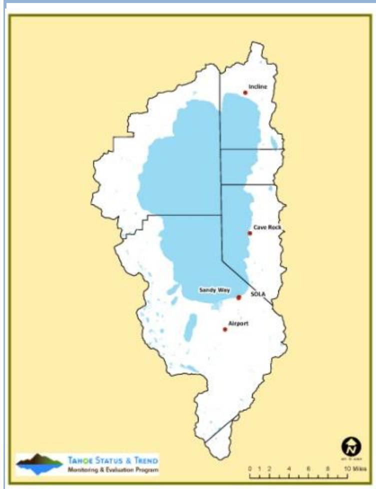


HIGHEST 1-HOUR AVERAGE CONCENTRATION
Status: **At or Somewhat Better than Target**
Trend: **Little or No Change**
Confidence: **Moderate**



The highest 1-hour ozone concentration (parts per million, ppm) measured at any of the monitoring sites in the Lake Tahoe Air Basin. The 2011 concentration is better than the most conservative TRPA Threshold Standard. However, historical values have exceeded Threshold Standards. Although the trend line indicates a slightly improving trend, it is not statistically significant due to the high inter-annual variability in indicator values (Slope=-0.0003, S=-65, P=0.092). Data Sources: California Air Resources Board (CARB) and Washoe County Air Quality Management District (WCAQMD).

Map



Ozone monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – Ozone (O_3), in high concentrations can cause health effects such as lung inflammation and other respiratory illness. Ozone can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. TRPA, federal and state standards have been adopted to protect human health. This indicator addresses the highest monitored O_3 concentration averaged over every 1 hour for the calendar year.
Threshold Category – Air Quality
Threshold Indicator Category - Ozone
Adopted Standards – TRPA: Maintain ozone concentrations at or below 0.080 parts per million averaged over 1 hour; California: 0.090 ppm not to be exceeded; Nevada: 0.100 ppm, not to be exceeded
Type of Standard – Numerical
Indicators (Unit of Measure) – Highest one-hour average concentration of Ozone measured at any monitoring station within a calendar year in the Lake Tahoe Air Basin (ppm).
Status – The highest 1-hour average O_3 concentration in 2011 was measured at the Incline Village monitoring site, reporting a value of 0.077 ppm (EPA 2011a). This measurement is 4% below the most stringent TRPA standard of 0.080 ppm. A condition status of “at

or somewhat better than target" is designated for 2011. The Region has been in attainment with this standard in 2003, 2004, and 2009-2011.

Trend – Trend was calculated using the Theil regression method (Theil 1950). **Long-Term Trend** - Between 1984 and 2011 there was not a statistically significant change in the highest 1-hour average O_3 concentrations (Slope=-0.0003, S=-65, P=0.092). Change in highest concentration was -0.0003 ppm/yr. This change was -0.3% per year of the most stringent (TRPA) standard of 0.08 ppm; consequently a "little or no change" designation was applied to this indicator.

Five-Year Trend – The trend over the most recent 5 years (2007-2011) is consistent with the long-term trend, and indicates a decrease of 0.0055 ppm/year in the highest 1-hour average O_3 concentration, or -6.9% per year of the standard. Note that short-term trends in air quality are typically not reliable due to the high inter-annual variability of meteorology and small sample size (n=5).

Confidence

Status – There is "moderate" confidence in the status determination because although the data were collected using federal reference methods (EPA 2011b), were subject to quality assurance requirements, and have been collected continuously in the Region since 1984, the spatial distribution and density of monitoring stations is probably insufficient to know with certainty whether maximum pollutant concentrations have been detected.

Long-term Trends – The confidence in the long-term trend determination for the highest 1 hour O_3 values (n=28) is "high", with a confidence level of 95%,(p=0.05) and an S-value of - 85.

5-Year Trend – The confidence in the trend over the most recent 5 years (2007-2011) is "moderate," with a confidence level of 76%, (p=0.24) and an S-value of – 5.

Overall Confidence - The overall confidence in the status and trend is "moderate" because there was "moderate" confidence determination made for status.

Interim Target – Available ozone monitoring data indicated that the Region is currently in attainment with regional, state and federal standards, and therefore, it is not necessary to establish an interim target.

Target Attainment Date – Available ozone monitoring data indicated that the Region is currently in attainment with regional, state, and federal standards, and therefore, it is not necessary to establish an attainment date.

Human & Environmental Drivers – Ozone is considered a secondary pollutant, created by photochemical reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in sunlight. The primary sources of HC and NOx include in-basin mobile sources (cars, trucks, boats, aircraft, off-road vehicles, etc.), biomass burning (wood stoves, wildfires, prescribed burning), and consumer products such as solvents. Ozone is also transported into the Basin to a lesser extent from populated areas surrounding the Basin. The ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed, and mixing conditions. Typically, the greater the volume of sources contributing to precursor gas concentration (e.g., increased traffic volume) during optimal weather conditions (cloudless days), the higher the concentration of Ozone.

Monitoring Approach – Ozone has been monitored at a number of locations around the Lake Tahoe Basin over the review period: South Lake Tahoe - Tahoe Blvd.; South Lake Tahoe-Sandy Way; South Lake Tahoe-Airport Rd.; Incline Village; and Cave Rock. In 2009, O_3 was monitored at the site in Incline Village by the Washoe County Air Quality Management Division (WCAQMD), and in South Lake Tahoe on Airport Road by the California Air Resources Board. Data is collected, analyzed, and reported by the respective agency (WCAQMD 2011; CARB 2011a). The data presented in the graph above is the highest monitored concentration measured at different sites for each year.

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, and Tahoe Regional Planning Agency.

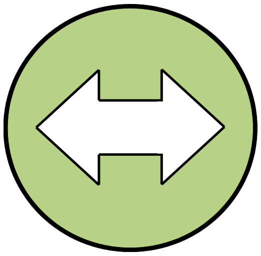
Programs and Actions Implemented to Improve Conditions – Regional, state and/or federal emission standards for motor vehicles, motorized watercraft, gas appliances, and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days. Prohibited development of new "drive-up window" establishments.

Effectiveness of Programs and Actions – Although there appears to be a slightly improving indicator trend, it is uncertain if existing programs are effective at improving conditions due to high inter-annual variability in indicator values.

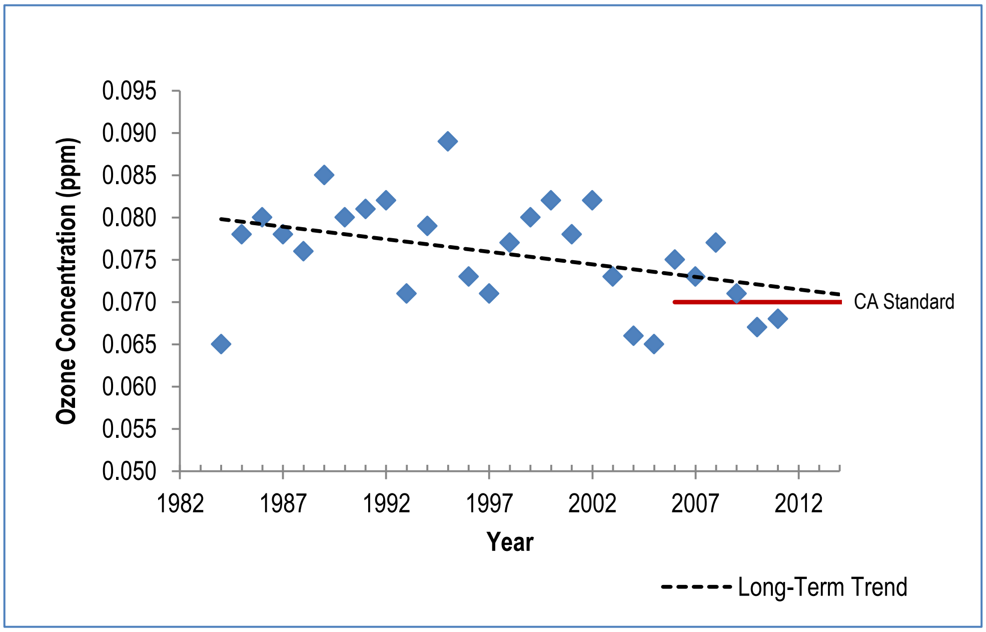
Recommendations for Additional Actions – Because this indicator varies into and out of compliance with the adopted Threshold Standard, it is recommended that the agency continue to encourage policies and management actions that result in reduction in regional sources of precursor gas emissions (e.g., reduce private automobile use, support state and federal efforts to apply tail pipe emission standards for motorized watercraft, lawn equipment, off-road vehicles, on-road motorcycles). For example, revised land use policies that facilitate the use of alternative modes of transportation (walking, bicycling, public transportation options) would contribute to the reduction of private automobile sources of hydrocarbons and oxides of nitrogen. It is recommended to continue monitoring ozone concentration trends. Agencies should consider establishing additional monitoring sites and work towards maintaining monitoring sites for the long-term to reduce the discontinuity of data collection. Use future monitoring data to inform and refine remedial actions beyond those currently being implemented as appropriate.

Ozone: **Highest 8-hour Average Concentration of Ozone**

Reporting Icon	Trend

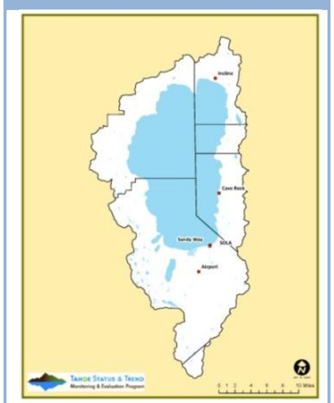


HIGHEST 8-HOUR AVERAGE CONCENTRATION
Status: **At or Somewhat Better than Target**
Trend: **Little or No Change**
Confidence: **Moderate**



The highest 8-hour average concentration (part per million, ppm) measured at any of the monitoring stations in the Lake Tahoe Basin. Concentrations generally have been worse than the California standard except most recently in 2010 and 2011, and in 1984, 2004 and 2005 when the region met the California standard (adopted in 2006 and represented with a red horizontal line). The long-term trend shows a gradual reduction in highest 8-hour ozone concentrations between 1984 and 2011 (Slope= 0.00033, S=-101, P=0.025). Data Sources: California Air Resources Board (CARB) and Washoe County Air Quality Management Division (WCAQMD).

Map



Ozone monitoring locations in the Lake Tahoe Basin

Data Evaluation and Interpretation

Relevance – This indicator addresses the highest monitored O_3 concentration averaged over every 8 hours for the calendar year. Ozone (O_3), in high concentrations, can cause health effects such as lung inflammation and other respiratory illness. Ozone can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. Standards, with varying time averaging periods, have been adopted to protect human health.

Threshold Category – Air Quality

Threshold Indicator Category - Ozone

Adopted Standards – TRPA/Nevada: no adopted standard. California: 0.070 ppm, highest 8-hour average concentration not to be exceeded

Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 8-hour average concentration measured within a calendar year at any monitoring site

Status – The highest 8-hour average O_3 concentration in 2011 was measured at the Incline Village monitoring site, measuring 0.068 ppm (EPA 2011a). The 2011 measurement of 0.068 ppm is 3% below the CA standard of 0.070 ppm. A status determination of "at or somewhat better than target" is designated for 2011. The Region was in attainment with the CA standard in 1984, 2004, 2005, 2010 and 2011; otherwise, the Region has not attained this standard.

Trend – Trend was calculated using the Theil regression method (Theil 1950). **Long-term Trend** - The graph above illustrates a long-term (1984 to 2011) gradual decline in highest 8-hour ozone concentration of -0.00033 ppm/yr. This change is -0.47% per year of the CA standard of 0.070. Consequently, the long-term trend was determined to be "little or no change" in the highest 8-hour average O_3 concentration. **5 Year Trend -** The trend in the most recent 5 years (2007-2011) is consistent with the long-term trend, and also indicates a decrease in the highest 8-hour average values by -0.002 ppm/yr., or -2.9% per year of the CA standard. Note that short-term trends in air quality are typically not reliable due to the indicator's inter-annual variability, response to meteorology, and the small sample size (n=5).

Confidence -

Status – There was "moderate" confidence in the status determination because even though the data 1) were collected using federal reference methods (EPA 2011b), 2) were subject to quality assurance requirements, and 3) have been collected continuously in the Region since 1984, the spatial distribution and density of monitoring stations is probably insufficient to know with certainty whether maximum pollutant concentrations have been detected.

Long-term Trend – The confidence in the long-term trend for the analysis of 28 data points of the highest 8-hour average O_3 concentration was determined to be "moderate" even though p= 0.02 and an S-value of -101 because, although there is continuous ozone monitoring data collected for the region, the duration of monitoring at a particular monitoring site tends not to be continuously collected. Consequently, the confidence rating for trend was reduced.

5 Year Trend – The confidence in the trend over the most recent 5 years (2007-2011) is "moderate," with a confidence level of 88% (p=0.12), and an S-value of -6.

Overall Confidence – The overall confidence in the status and trend is "moderate" because there is a "moderate" confidence in status and a "moderate" confidence in long-term trend.

Interim Target – The Highest 8-hour Average Concentration of Ozone indicator is currently in attainment with the CA standard of 0.070 ppm and therefore, it is not necessary for an interim target to be established.

Target Attainment Date – The Highest 8-hour Average Concentration of Ozone indicator is currently in-attainment with the CA standard of 0.070 ppm and therefore, it is not necessary for an interim target date to be established.

Human and Environmental Drivers – Ozone is considered a secondary pollutant, created by photochemical reactions between hydrocarbons (HC), and oxides of nitrogen (NOx) in sunlight. The primary sources of HC and NOx include in-basin mobile sources (cars, trucks, boats, aircraft, off-road vehicles, etc.), biomass burning (wood stoves, wildfires, prescribed burning), and consumer products such as solvents. Ozone is also transported into the Basin to a lesser extent from populated areas surrounding the Basin, and the ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed, and mixing conditions. Typically, the greater the volume of sources contributing to precursor gas concentration (e.g., increased traffic volume) during optimal weather conditions (cloudless days), the higher the concentration of Ozone.

Monitoring Approach – Ozone has been monitored at a number of locations around the Lake Tahoe Basin over the review period: South Lake Tahoe- Tahoe Blvd.; South Lake Tahoe-Sandy Way; South Lake Tahoe-Airport Rd.; Incline Village; and Cave Rock. In 2009, O_3 was monitored at the site in Incline Village by the Washoe County Air Quality Management Division, and in South Lake Tahoe on Airport Road by the California Air Resources Board. Data is collected, analyzed, and reported by the respective agency (WCAQMD 2011; CARB 2011a). The data presented in the graph above represent the highest monitored concentration at all sites for each year.

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, and Tahoe Regional Planning Agency

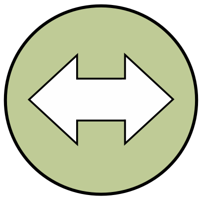
Programs and Actions Implemented to Improve Conditions – Regional, state and/or federal emission standards for motor vehicles, motorized watercraft, gas appliances and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days. Prohibited development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Although there appears to be a slightly improving long-term indicator trend (however not statistically significant), it is uncertain if existing programs are effective at improving conditions due to high inter-annual variability of indicator values. Directed effectiveness monitoring would improve agencies' certainty in understanding the effectiveness of specific programs and actions designed to reduce ozone impacts.

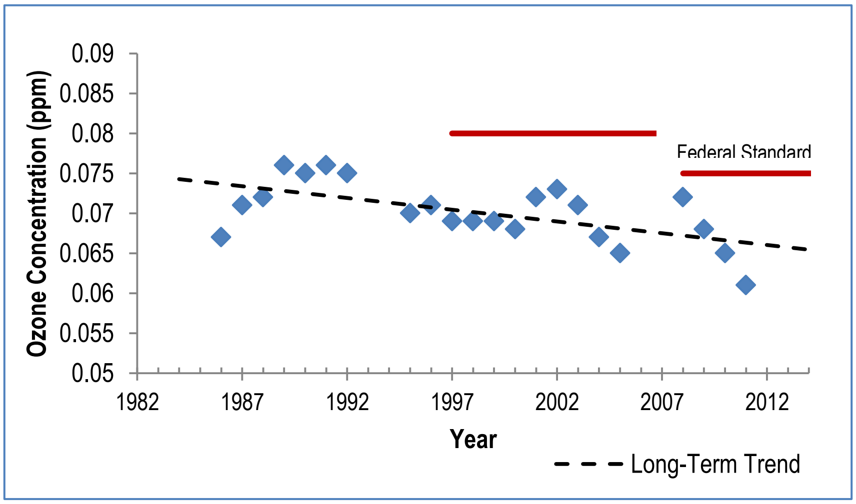
Recommendations for Additional Actions – Although the current status of this indicator is "at or somewhat better than target," current programs and activities could be more effectively implemented or redesigned. For example, goals of these programs and activities could include reducing the dependency on the private automobile (through landuse policy that incentivizes more bicycle-friendly and walkable town-centers) and/or encouraging the use of alternative modes of transportation such as public transportation. It is recommended that the agency continue to encourage policies and management actions that result in reduction in regional sources of precursor gas emissions (e.g., reduce private automobile use, support state and federal efforts to apply tail pipe emission standards for motorized watercraft, lawn equipment, off-road vehicles, on-road motorcycles). It is also recommended to investigate and refine our understanding of the sources and relative contributions of mobile and stationary precursor gases at the regional scale (include both Nevada and California), and develop a cost feasible and implementable strategy that leads to the reduction of major sources of precursor gases.

Ozone: **3 Year Average of the 4th Highest 8-hour Average Ozone Concentration**

Reporting Icon	Trend

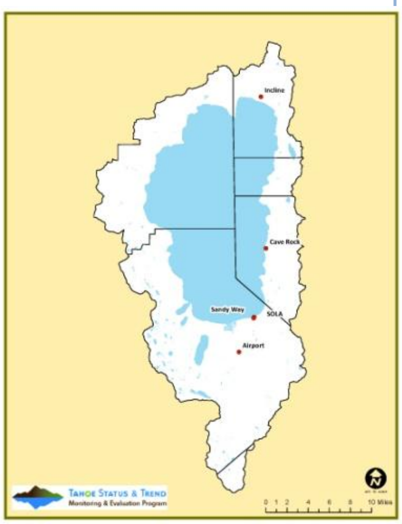


3-YEAR AVERAGE OF 4th HIGHEST CONCENTRATION
Status: **At or Somewhat Better Than Target**
Trend: **Little or No Change**
Confidence: **Moderate**



The highest 3-year average of the 4th highest 8-hour ozone concentration recorded at any monitoring site in the Lake Tahoe Basin. The federal standard changed in May 2008 (note shift in red line). The long-term trend (dashed line) has shown a gradual decline over the period of record from 1986 through 2011 (Slope=0.0003, S=-95, P=0.003). Data Sources: California Air Resources Board (CARB) and Washoe County Air Quality Management Division (WCAQMD).

Map



Ozone monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – This indicator addresses the 3-year average of the 4th-highest 8-hour average O_3 concentration, which is the basis of the federal standard. Ozone (O_3), in high concentrations can cause health effects such as lung inflammation and other respiratory illness. Ozone can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. TRPA, and federal and state standards, with varying time averaging periods, have been adopted to protect the public from this harmful pollutant.
Threshold Category – Air quality
Threshold Indicator Category – Ozone
Adopted Standards – Federal: The 3-year average of the 4th-highest daily maximum must not be exceed concentration standard of 0.075 ppm.
Type of Standard – Numerical
Indicator (Unit of Measure)- 3-year average of the 4th-highest daily maximum ozone concentration (ppm)
Status – The 3-year average of the 4th-highest 8-hour average O_3 concentration is calculated based on the 4th-highest 8-hour average data values from the EPA AQS website (EPA 2011a) for the Lake Tahoe Air Basin. The 2011 values for the Incline

Village and Cave Rock sites were 0.059 and 0.053 ppm (respectively). Averaging values the Incline Village site from 2009-2011, a 3-year average of 0.061 ppm was calculated. This 3-year average value of 0.061 ppm is 19% below the federal standard of 0.075 ppm, and therefore, a status of "at or somewhat better than target" has been determined. The monitoring record indicates that the Region has never violated this federal standard.

Trend – Trend was calculated using the Theil regression method (Theil 1950). The graph above illustrates there was a gradual decline in indicator values between 1984 and 2011 of -0.0003 ppm/yr (S=-95, P=003). This change is -0.4% per year of the federal standard of 0.075 and resulted in a trend determination of "little or no change" in the indicator values.

Confidence

Status – There is "moderate" confidence in the status because although the data were collected using federal reference methods (EPA 2011b) that are subject to extensive quality assurance requirements, there are noted data gaps for 1993 and 1994, 2006 and 2007, and the spatial distribution and density of monitoring stations is likely insufficient to detect with certainty variation in pollutant concentrations.

Long-term Trend – Even though trend statistics indicate high confidence in long term trend determination, the gaps in the monitoring record, discontinuous monitoring at individual monitor sites and the limited distribution of monitoring sites are reduce to a "moderate" determination

5 Year Trend – The trend over the most recent 5 years could not be determined because of data gaps recorded in 2006 and 2007.

Overall Confidence – The overall confidence in the status and trend is "moderate" because there was "moderate" confidence in status and "moderate" confidence in long-term trend.

Interim Target – No interim target was identified because the Region is currently in attainment with the standard.

Target Attainment Date – An attainment date was not identified because the Region is currently in attainment with the standard.

Human & Environmental Drivers – Ozone is considered a secondary pollutant, created by photochemical reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in sunlight. The sources of HC and NOx include mobile sources (cars, trucks, boats, aircraft, off-road vehicles, etc.), biomass burning (wood stoves, wildfires, prescribed burning), and consumer products such as solvents. Ozone is transported from populated areas around the Lake Tahoe Basin into the Basin, and the ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed and mixing conditions.

Monitoring Approach – Ozone has been monitored at a number of locations around the Lake Tahoe Basin over the review period: South Lake Tahoe- Tahoe Blvd.; South Lake Tahoe-Sandy Way; South Lake Tahoe-Airport Rd.; Incline Village; and Cave Rock. In 2009, O_3 was monitored at the site in Incline Village by the Washoe County Air Quality Management Division, and in South Lake Tahoe (Airport Road) by the California Air Resources Board. Data is collected, analyzed, and reported by the respective agency (WCAQMD 2011; CARB 2011a). In the summer of 2011, the Placer County Air Pollution Control District (PCAPCD) established a new ozone monitoring site in Tahoe City. Results of the monitoring are not yet available.

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, and Tahoe Regional Planning Agency

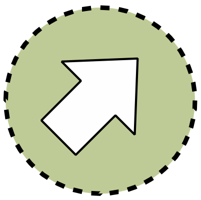
Programs and Actions Implemented to Improve Conditions – Regional, state and/or federal emission standards for motor vehicles, motorized watercraft, gas appliances and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days. Prohibited development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Existing programs and actions implemented to affect this indicator appear to be effective based on the long-term indicator data, which shows that the standard has not been exceeded in the years that monitoring occurred.

Recommendations for Additional Actions – Although the current status of "at or somewhat better than target" was determined, additional action may be needed to continue maintenance of this indicator below the current standard. Additional actions may be necessary to reduce sources of ozone precursor gases, including improving the public transportation system, walkability, and bicycle access to town centers. It is recommended to continue monitoring ozone concentration trends. If conditions worsen, consider additional remedial actions.

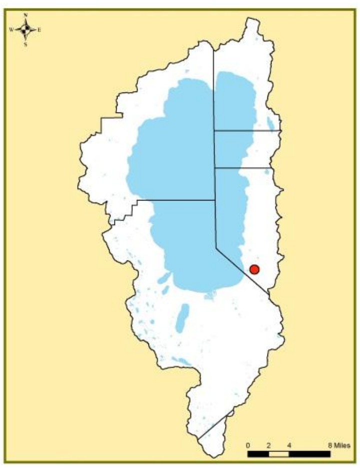
Ozone: **Oxides of Nitrogen Emissions (Average tons/day)**

Reporting Icon



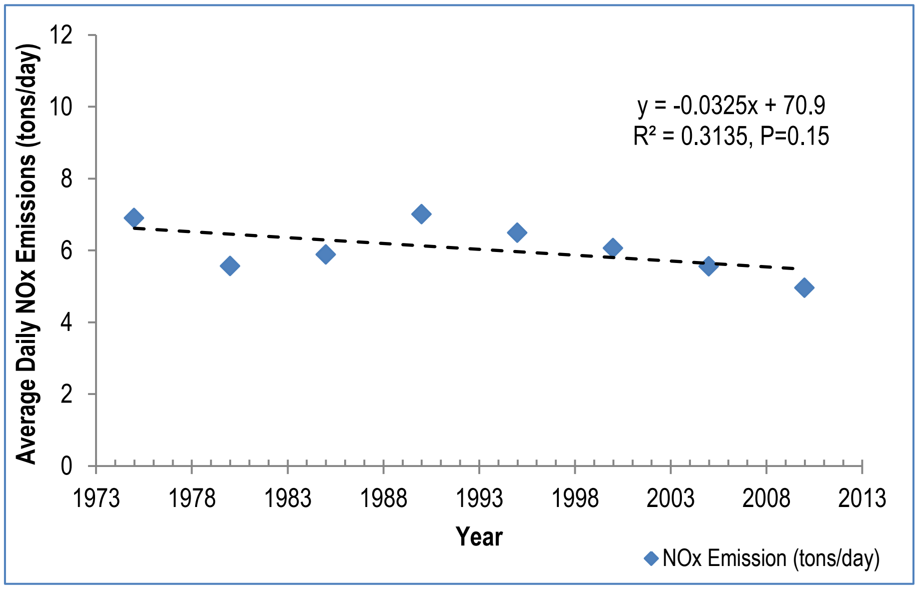
OXIDES OF NITROGEN EMISSIONS
Status: **At or Somewhat Better Than Target**
Trend: **Moderate Improvement**
Confidence: **Low**

Map



NOx monitoring equipment was placed at TRPA offices at Stateline, NV in summer 2010.

Trend



Trend in estimated Nitrogen Oxide emissions (tons/day) for the California portion of the Lake Tahoe Region. Source: CARB (2008) Emission Inventory for the California Portion of the Lake Tahoe Air Basin.

Data Evaluation and Interpretation

Relevance – This indicator estimates the daily emissions of NOx based on the California Air Resources Board (CARB) Emission Inventory for the California portion of the Lake Tahoe Region. Nitrogen dioxide is one of a group of highly reactive gasses known as "oxides of nitrogen," or "nitrogen oxides." Other nitrogen oxides include nitrous acid and nitric acid. While federal standards cover the entire group of NO_x, NO_2 is the component of greatest interest, and the indicator for the larger group of NO_x. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with regional haze, global warming, water quality degradation, and a number of adverse effects on the respiratory system (EPA 2011e). Current scientific evidence links short-term NO_2 exposure (30 minutes to 24 hours) with adverse respiratory effects, including airway inflammation in healthy people, and increased respiratory symptoms in people with asthma (EPA 2011c).

Threshold Category – Air Quality

Threshold Indicator Category – Ozone

Adopted Standards – TRPA: Maintain oxides of nitrogen (NOx) emissions at or below the 1981 level (i.e., maintain oxides of nitrogen (NO_x) emissions at or below 9.4 tons per day for an average summer day, as reported in the Study Report for the Establishment of Environmental Threshold Carrying Capacities (TRPA 1982a)); CA: Annual average NO_2 concentration not to exceed 30ppb (0.030 ppm), highest one-hour, not to exceed 0.18ppm; NV/Federal: Annual average NO_2 concentration not to exceed 53ppb (0.053ppm), highest one-hour not to exceed 0.10 ppm.

Type of Standard – Numerical

Indicator (Unit of Measure) – Average tons/day of NOx emission (ton/day), annual and highest one-hour NO_2 concentrations (ppm)
Status – Based on the CARB Emission Inventory for the California portion of Lake Tahoe Region, NOx emissions in 2010 were estimated at 4.95 tons per day, which is about 11% lower than the 1980 (the date closest to the date identified in the adopted Threshold Standard) estimate of 5.56 tons per day, and 29% lower than the 1990 estimate of 7 tons/day. Based on emission estimates for the California portion of the Basin in 2010, it was concluded that the current status determination is "at or somewhat better than target," because emission estimates were below 1980 estimates for the California portion of the Basin. TRPA (1982a) estimated NOx emissions in 1980 for the entire Lake Tahoe air basin at 9.4 tons/day. Preliminary results from the new TRPA monitoring station (August through November 2011) indicated that the highest average 1-hour NO_2 concentration was 0.02 ppm. These results preliminarily indicate that the Region is meeting the California and federal 1-hour NO_2 standard of 0.18ppm and 0.10ppm, respectively.
Trend – The trend was calculated using a simple linear regression analysis. Based on the California Air Resources Board (CARB) emissions inventory estimates for the California portion of the Lake Tahoe Region, average per day NOx emissions have decreased at a rate of -0.035 tons/day since 1980 and are projected to continue to decrease through 2020. This represents a -0.6% percent change resulting in a trend determination of "moderate improvement."
Confidence – Because NO_x emissions are based on modeled outputs and the estimates only represent the California portion of the Lake Tahoe air basin, a "low" confidence rating is assigned to both status and trend determinations.
Interim Target – According to NOx emission estimates provided by CARB, the Region is in attainment with the adopted TRPA Threshold Standard, and therefore it is not necessary to establish an interim target for this indicator.
Target Attainment Date – According to NO_x emission estimates provided by CARB, the Region is in attainment with the adopted TRPA Threshold Standard, and therefore it is not necessary to establish a target attainment date.
Human & Environmental Drivers - NO_x gasses are formed during fuel combustion. NO_x forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. NO_x reacts with ammonia, moisture, and other compounds to form nitric acid vapor and related particles (EPA 2011c). Small particles can penetrate deeply into lung tissue, causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases such as emphysema and bronchitis, and it may also aggravate existing heart disease. NO_x reacts with volatile organic compounds in the presence sunlight to form Ozone. Ozone can cause adverse effects such as damage to lung tissue and reduction in lung function, mostly in susceptible populations (children, elderly, and asthmatics). Ozone can be transported by wind currents and cause health impacts far from the original sources.
Monitoring Approach – California Air Resources Board (CARB) compiles data to create the criteria pollutant emission inventory, which includes information on the emissions of reactive organic gases (ROG), oxides of nitrogen (NOx), oxides of sulfur (SOx), carbon monoxide (CO), and particulate matter (PM_{10}). Data are gathered on an ongoing basis and stored in the California Emission Inventory Development and Reporting System (CEIDARS). A summary of the criteria pollutant inventory is published annually. The California emission inventory contains information on the following air pollution sources:

- Stationary sources - approximately 13,000 individual facilities, called point sources. Point sources are fixed pollution sources such as electric power plants and refineries. There are also about 135 aggregated point source categories. These categories estimate emissions for the non-point source stationary sources
- Area-wide sources - approximately 80 source categories. An area-wide source category is made up of sources of pollution mainly linked to the activity of people. Examples of these sources include consumer products and architectural coatings used in a region
- Mobile sources - all on-road vehicles such as automobiles and trucks; off-road vehicles such as trains, ships, aircraft; and farm equipment

The principal agencies contributing data to the stationary and area-wide source inventory are the CARB and the California air pollution control and air quality management districts. The CARB, the California Department of Transportation (Caltrans), and regional transportation agencies are the principal agencies involved in developing the mobile source inventory. Information represented in the California emission inventory is a snap-shot of a variety of dynamic and variable processes. As such, the emission inventory can only represent an estimate of what is actually occurring. In summer 2011, a new NO_x monitoring station was established at the TRPA Stateline, NV office. This site will be used for future NO_x concentration monitoring and reporting.
Monitoring Partners – California Air Resources Board and Tahoe Regional Planning Agency. Funding for the TRPA NO_x monitoring site was provided by Nevada Department of Motor Vehicles.
Programs and Actions Implemented to Improve Conditions – Regional, state and/or federal emission standards for motor vehicles, motorized watercraft, gas appliances and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Low emission public transportation systems. Restricted development of "drive-up window" commercial uses.
Effectiveness of Programs and Actions – Existing federal, state and regional programs and actions appear to be effective, based on CARB emission estimates. The CARB Emission Inventory indicates a decreasing trend in NOx emissions, which indicates the effectiveness of state and federal vehicle emission standards and programs implemented through the *Regional Transportation Plan*.
Recommendations for Additional Actions – A Threshold Standard amendment is recommended to clarify the existing TRPA NO_x

standard. It is also recommended to favor the adoption of a Numerical Standard consistent with state and federal concentration standards because baseline NO_x emissions in 1981 were not documented (only 1980 NO_x emission estimates were reported). Measurement of NO_x concentration would more accurately represent contributions from all sources of NO_x, not just vehicle associated NO_x as represented by modeled NO_x values presented here. It is recommended to continue monitoring modeled NO_x emissions for an additional 5 years, contemporaneously with NO_2 concentrations for comparison purposes.

Visibility

This section addresses Threshold Standards in Resolution 82-11 that are associated with the Visibility Indicator Reporting Category, and includes indicators related to particulate matter (as a proxy for wood smoke and suspended soil particles, and known to effect human health), regional and sub-regional visibility, and vehicle miles traveled.

Atmospheric particulate matter consists of very small liquid and solid particles, designated PM_{10}, for particulate matter of 10 microns (10µ) or less in diameter. The primary sources of PM_{10} in the Basin are motor vehicles, pulverized road-traction abrasives, decomposed road surfaces, salt, fugitive dust from local sources and from abroad, and smoke from residential burning, prescribed burning, and wildfires. PM_{10} is among the most harmful of all air pollutants. When inhaled, these particles invade the respiratory system's natural defenses and lodge deep in the lungs. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. These effects are particularly harmful to children, active adults, and the elderly. In addition, PM_{10} plays a substantial role in the decline in visibility in the Basin (Sacks et al. 2010).

Particles small enough to be inhaled into the deepest parts of the lungs are another concern to public health. These fine particles are known as $PM_{2.5}$, for particulate matter of 2.5 microns (2.5µ) or less in diameter. Due to this pollutant's tiny size, it can be inhaled deep into the lungs and can make its way directly into the bloodstream. Some of these particles are generated by combustion and they can contain carcinogens. For this reason, state and federal governments have adopted standards and placed increasing efforts on the study of this pollutant.

Atmospheric particles are also known to settle out of the air and deposit onto the landscape, including into Lake Tahoe. Lahontan Water Quality Control Board (LWQCD) (2010) has implicated particles equal or smaller than 16µ diameter in the decline of Lake Tahoe transparency, and estimated that about 15 percent of the particle loads to Lake Tahoe are from atmospheric sources. Measures of particulate matter concentrations, PM_{10} and $PM_{2.5}$, may in part provide a surrogate measure of this atmospheric pollutant known to affect Lake Tahoe's transparency.

TRPA primarily established Threshold Standards for "visibility" to protect the unique aesthetic scenic values of the Tahoe Region. Visibility measures the distance at which an object or light can be clearly discerned by the human eye. Light through the atmosphere is scattered, or absorbed by gases and airborne particles, causing a reduction in visibility. Without anthropogenic influences, visual range can be up to 400 km (248.5 miles). Several natural phenomenon and human generated pollutants are known to impair visibility within a region, including fog, ice fog, mist, haze, smoke, volcanic ash, dust, sand, and snow. Haze is a term used to describe an atmospheric phenomenon where dust, smoke, and other dry particles obscure the clarity of the sky. When viewed from around Lake Tahoe's shoreline or atop the Basin's ridgeline, haze may appear brownish or bluish, while mist or fog tends to be bluish-grey. Sources of locally generated haze pollutants include entrained/suspended roadway particles, vehicle emissions, residential wood burning, campfires, prescribed fires, and wildfires (Green et al. 2011; Kuhns et al. 2004). Some particles responsible for the degradation of regional visibility in the Lake Tahoe Region include dust and other pollutants, transported into the Basin from areas as far as Asia (Green et al. 2011).

TRPA's Visibility Threshold Standards aim to improve, and then maintain, air quality (at the regional and sub-regional scale) at a level that is dominated by haze-free or high-visibility days. The regional Visibility

Threshold Standard established visibility objectives for the entire Basin, while the sub-regional Visibility Threshold Standard established a local visibility objective for the South Lake Tahoe portion of the Tahoe Basin.

According to TRPA Resolution 82-11, the Visibility Indicator Reporting Category includes two Numerical Standards for regional visibility.
These standards are:

1. Achieving an extinction coefficient[4] of 25 Mm^{-1} at least 50 percent of the time, as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 156 kilometers (97 miles))
2. Achieving an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 115 kilometers (71 miles))

In addition, there are two Numerical Standards for sub-regional visibility. These standards are:

1. Achieving an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time, as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 78 kilometers (48 miles))
2. Achieving an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 31 kilometers (19 miles))

Three additional standards are:

1. Reducing suspended soil particles by 30 percent of the 1981 base values through technology, management practices, and educational programs
2. Reducing wood smoke emissions by 15 percent of the 1981 base values through technology, management practices, and educational programs
3. Reducing vehicle miles travelled by 10 percent of the 1981 base values

Indicators associated with particulate matter were evaluated in place of wood smoke (WS) and suspended soil particle (SSP), because Numerical Standards for WS and SSP have not been established. Also, technologies have not sufficiently advanced to accurately discriminate WS and SSP generated within the Region, from those generated outside of, and transported into, the Lake Tahoe air basin.

To characterize average overall visibility conditions for the Visibility Indicator Reporting Category, indicators associated with particulate matter, regional visibility, and vehicle miles traveled were evaluated. Although available data are summarized and reported here, status and trend determinations for sub-regional visibility and annual average PM_{10} indicators were not included in the overall characterization for visibility due to insufficient data. Overall, the evaluation of indicators with sufficient data suggests that the Tahoe Region is “at or somewhat better than target,” with a “moderately improving” trend. Although the confidence score for aggregated indicators suggests a “moderate” level of confidence, it was determined to be “low” due to the omission of data (classified as “unknown”) associated with three of the nine indicators evaluated for this Indicator Reporting Category (Figure 3-3, Annual Average PM10 Concentrations, Sub-regional visibility [50% and 90% days])).

[4] *A measure of light absorption and scattering in the atmosphere measured in inverse megameters (Mm^{-1})*

Overall Status and Trend of the Visibility Indicator Reporting Category

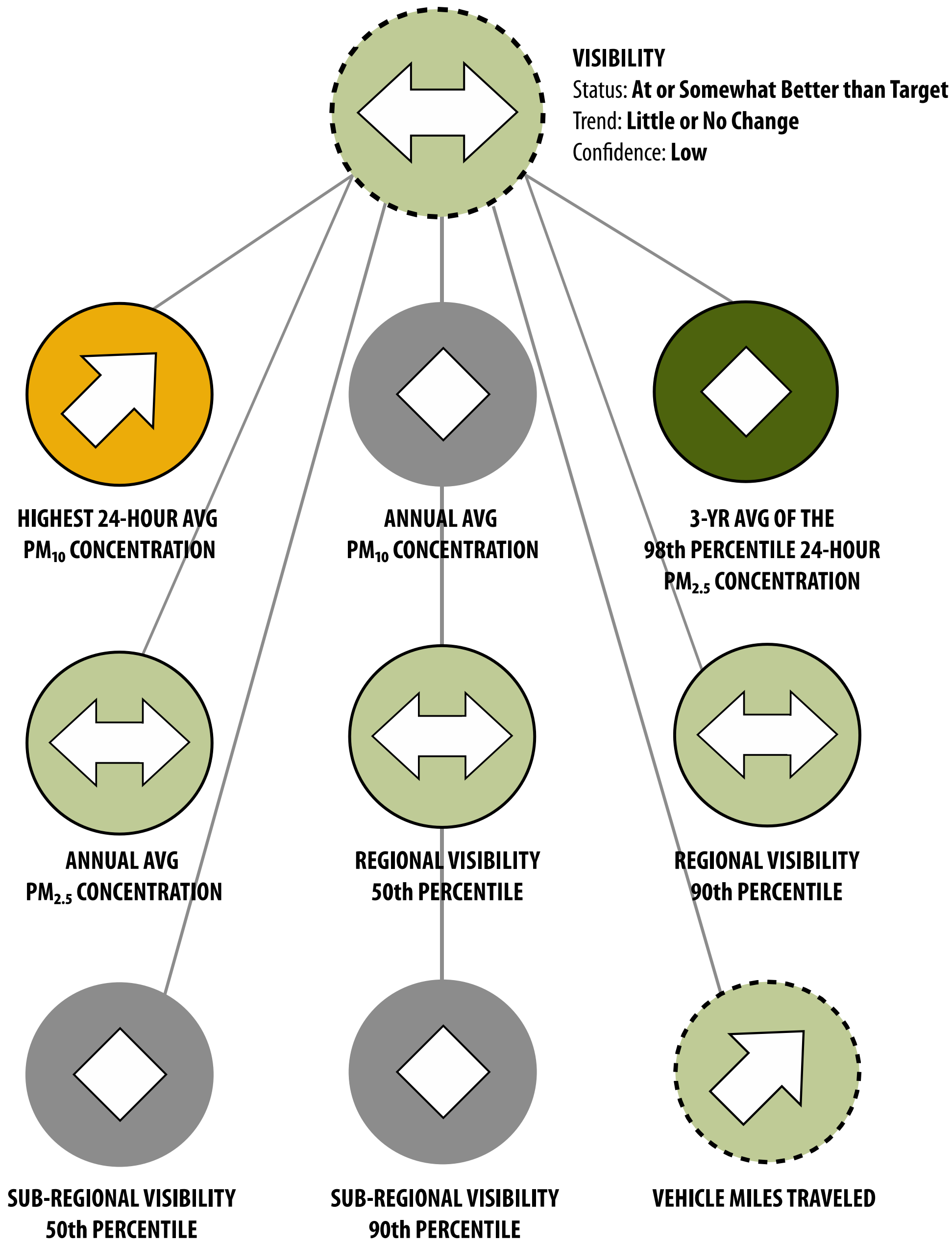
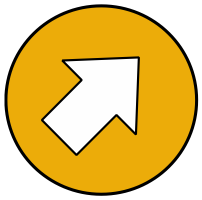


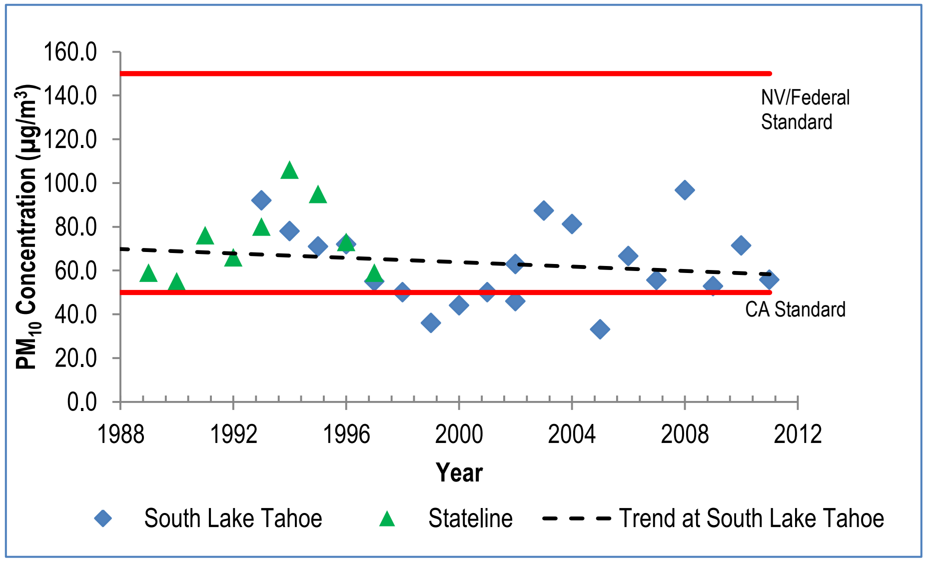
Figure 3-3. *Reporting icons for the nine indicators evaluated in the Visibility Indicator Reporting Category. Results from six of the indicators (for which data existed) were evaluated and aggregated to characterize the overall status of the Visibility Indicator Reporting Category (top).*

Visibility: **Highest 24-Hour Average PM_{10} Concentration**

Reporting Icon	Trend

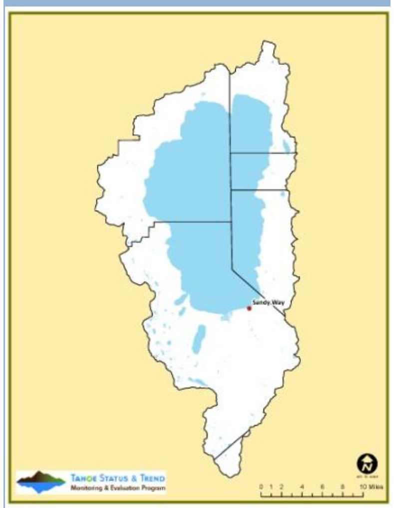


HIGHEST 24-HOUR AVG PM_{10} CONCENTRATION
Status: **Somewhat Worse Than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**



The highest 24-hour average particulate matter less than or equal to 10 microns in size (PM_{10}) concentration in the Lake Tahoe Basin. Concentrations are all better than the Nevada standard, but somewhat worse than the California standard. The long-term trend at the South Lake Tahoe site showed gradual improvement over the monitoring record from 1989 through 2011, however, due to high inter-annual variation, this trend was not statistically significant (Slope=-0.5, S=-12, P=0.365).

Map



PM_{10} monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – This indicator measures the highest monitored PM_{10} concentration averaged over every 24 hours for the calendar year. These results provide a proxy measure of wood smoke and suspended soil particles. Particulate matter in high concentrations less than or equal to 10 microns in size can lodge in the lungs and cause or aggravate the effects of asthma, lung diseases, and heart disease. Elevated concentrations of PM_{10} have also been attributed to reductions in regional visibility (increased regional haze). Federal and state standards, with varying time averaging periods, have been adopted to protect human health and to protect regional visibility.
Threshold Category – Air Quality
Threshold Indicator Category – Visibility
Adopted Standards – TRPA: TRPA does not have an adopted Threshold Standard for particulate matter. However, to protect regional visibility, it does have Numerical Standards for wood smoke and suspended soil: "*Reduce suspended soil particles by 30% of the 1981 base values through technology, management practices and educational programs. Reduce wood smoke emissions by 15% of the 1981 base values through technology.*" California: The highest 24 hour average concentration for PM_{10} does not exceed 50 $\mu g/m^3$; Nevada: The highest 24 hour average concentration for PM_{10} does not exceed 150 $\mu g/m^3$; Federal: Do not exceed the 150 $\mu g/m^3$ 24-hour mean concentration measured three years running.
Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 24-hour average concentration of PM_{10} within a calendar year measured at any site in the Tahoe Region (micrograms per cubic meter, µg/m^3).

Status – The highest 24-hour average PM_{10} concentration monitored in 2011 was 55.8 micrograms per cubic meter (CARB 2011a). This value is equal to 12% worse than the more conservative California standard of 50µg/m^3, and 63% better than the Nevada and federal standard of 150µg/m^3. Consequently, a status determination of "somewhat worse than target" was designated because the Region did not attain the more stringent of the standards. The Region was in attainment with the California standard in 1999, 2000, 2002, and 2005. The Region has never violated the federal or Nevada standard for PM_{10} over the length of the monitoring record.

Trend – The indicator trend was estimated using a Theil regression model (Theil 1950). **Long-term Trend** - There was an improving long-term trend detected between 1993 and 2011 of the highest 24-hour PM_{10} concentrations at the South Lake Tahoe site. The long-term trend represents a reduction in highest 24-hour average concentration of -0.5 µg/m^3/yr. This trend, however, was not statistically significant (Slope=-0.5, S=-12, P=0.365). This change is equal to -1% per year of the most conservative California standard of 50 µg/m^3. Consequently, the trend was determined to be "moderate improvement." **5-Year Trend -** The trend in the most recent 5 years (2007-2011) is consistent with the long-term trend, and indicates a decrease in highest 24-hour PM_{10} concentrations of 0.7 µg/m^3-yr., or -1.4% per year of the standard. Note that short-term trends in air quality are typically not reliable due to high inter-annual variability in the indicator value, and the small number of data points evaluated (n=5).

Confidence

Status – There is "high" confidence in the condition status because the data were collected using federal reference methods (EPA 2011b), is subject to extensive quality assurance requirements, and was collected continuously to date. However, the monitoring site where data are collected likely represents the worst case/condition scenario due to its proximity to high traffic volumes on highway 50 in South Lake Tahoe and thus does not accurately reflect the range of conditions throughout the airshed. CARB does not report the number of samples used to determine the highest 24-hour PM_{10} concentration, but instead provides a "year coverage" rating. Year coverage indicates, on a scale of 0 to 100, the extent that monitoring data are available for the time of year that historically has experienced the highest concentrations. Zero indicates that no part of the high time of year was monitored, whereas 100 indicates that all of the high time of year was monitored. The average year coverage rating for PM_{10} is 90, from 1992 to 2011.

Long-Term Trend – The confidence in the long-term trend for the analysis of 19 data points of the 24-hour average PM_{10} concentration is "moderate" with a confidence of 63% (P=0.365), an S value of -12. The high inter-annual variation in indicator values likely reduced the confidence determination for trend.

5-Year Trend – The confidence in trend for the most recent 5 years (2007-2011) is "low," with a confidence of 41%, an S value of 0, and a P value of 0.59.

Overall Confidence – The overall confidence in the status and trend is "moderate" because of low confidence in the trend determination.

Interim Target – Extending the indicator trend line out to 2016 results in an estimated interim target of 59 μg/m^3. The Region is already in attainment with Nevada and federal standards, and therefore it is not necessary to establish interim targets for those standards.

Target Attainment Date – The intersection between the strictest California standard (50μg/m^3) and modeled trend line estimates a California standard attainment date of 2040. The Tahoe Region is already in compliance with the federal/Nevada standards, and thus it is not necessary to establish a target attainment date for those standards**.**

Human & Environmental Drivers – Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of PM_{10} in the Lake Tahoe Basin are motor vehicle emissions, paved and unpaved road dust, wood smoke, wildfire smoke, and construction dust. The ambient concentration of PM_{10} is highly dependent on meteorological conditions such as wind speed and mixing conditions.

Monitoring Approach – PM_{10} concentrations evaluated in this summary were monitored at one location in the Lake Tahoe Basin, located on Sandy Way in South Lake Tahoe. This monitoring site represents a near-worst case/condition scenario site because it is closely located to a segment of Highway 50 in the South Shore of Lake Tahoe that receives some of the highest traffic volumes. Data are collected, analyzed, and reported by the California Air Resources Board (CARB 2011a).

Monitoring Partners – California Air Resources Board, U.S. Environmental Protection Agency, and Tahoe Regional Planning Agency

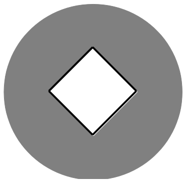
Program and Action Implemented to Improve Conditions – Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways, trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The observed declining trends in PM_{10} concentrations suggests that the programs and actions are somewhat effective at controlling concentrations of PM_{10}.

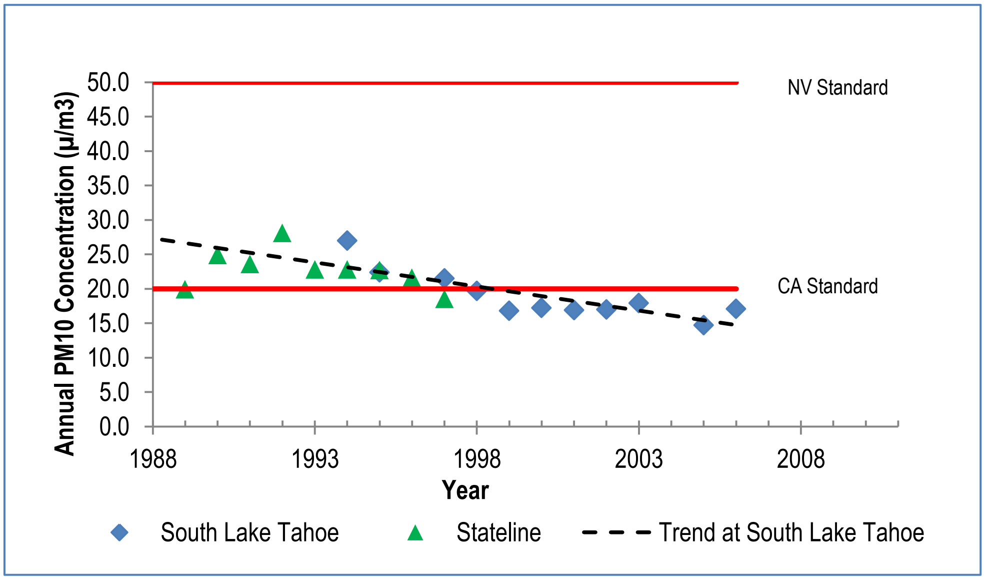
Recommendations for Additional Actions – Given that the current status of this indicator is not in attainment with the most conservative standard, and modestly improving in trend, suggests that the existing programs and actions could be more effectively implemented, such as more frequent street sweeping to control entrained road dust, continue to implement requirement that residential woods stove meet EPA emission standards, and perhaps, if conditions decline, consider options for restricting residential wood burning during periods of elevated ambient PM concentrations. Respective state air quality management authorities already regulate prescribed burning of forest biomass, where burning in the Region is only allowed during appropriate meteorological conditions and follow a burn plan. The current TRPA Threshold Standards for wood smoke and suspended soil particles should be reviewed and replaced with appropriate state and/or federal particulate matter concentration standards, to improve the agency's ability to objectively determine status and trends.

Visibility: **Annual Average PM10 Concentration**

Reporting Icon	Trend

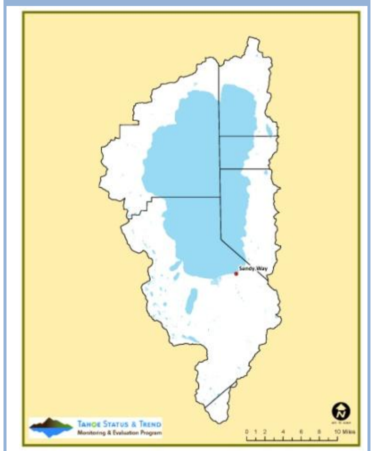


ANNUAL AVERAGE
PM10 CONCENTRATION
Status: **Unknown**
Trend: **Unknown**
Confidence: **N/A**



The annual average particulate matter less than or equal to 10 microns in size (PM_{10}) concentration measured at the Stateline, NV and South Lake Tahoe, CA sites from 1989 to 2006. When last measured and reported, concentrations were considerably better than Nevada standards and slightly better than California standards since the late 1990s. The long-term trend for the South Lake Tahoe, California site showed improvement over the 1989-2006 period of record (Slope -0.714, S=-31, P=0.008). PM_{10} data were not collected between 2007 and 2011, and thus current status and trend of this indicator were determined to be unknown.

Map



PM_{10} monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – This indicator measures the annual average concentration of particulate matter less than or equal to 10 microns in size (PM_{10}). In high concentrations this pollutant can lodge in the lungs and cause or aggravate the effects of asthma, lung diseases, and heart disease. Federal and state standards have been adopted to protect the public from this pollutant.

Threshold Category – Air Quality

Threshold Indicator Category – Visibility

Adopted Standards – TRPA: TRPA does not have an adopted Threshold Standard for Particulate Matter. However, it does have Numerical Standards for wood smoke and suspended soil particles to protect regional visibility; "*Reduce suspended soil particles by 30% of the 1981 base values through technology, management practices, and educational programs. Reduce wood smoke emissions by 15% of the 1981 base values through technology*." California: Do not exceed the 20 $\mu g/m^3$ PM_{10} annual average concentration; Federal: Do not exceed the 50 $\mu g/m^3$ annual average PM_{10} concentration measured three years running.

Type of Standard – Numerical

Indicator – Annual average PM_{10} concentrations measured at any permanent monitoring station within a calendar year ($\mu g/m^3$).

Status – The current status is designated as "unknown" because the most recently reported annual average PM_{10} concentration at the Sandy Way site was from 2006 (CARB 2011a), which is not representative of current conditions. The annual average PM_{10} concentration measured in 2006 was 17.1 $\mu g/m^3$, which is 86% of the CA standard of 20 $\mu g/m^3$. According to the available data record, the Tahoe Region was in attainment with this standard every year from 1998 through 2006. Available data related to the federal 3-year running average ranged from a high of 24 $\mu g/m^3$ in 1996, continually decreasing to 19 $\mu g/m^3$ in 2003 (data beyond 2003 were not available). PM_{10} is currently measured at the South Lake Tahoe site, but only during peak times of the year. While the site can provide data to support the determination of current status and trends for the highest 24-hour PM_{10} standard, insufficient data collection throughout the year prevents accurate assessment of annual average conditions in PM_{10}.

Trend – Trends were calculated from available data using a Theil regression model (Theil 1950). **Long-term Trend –** There was a long-term trend between 1994 and 2006 at the South Lake Tahoe site of decreasing annual average PM_{10} concentration of -0.7μg/m^{3}-yr. This change is equal to -3.5% per year of the most conservative California standard of 20 μg/m^{3}, and would indicate a "rapid improvement." However, because current data were not available, a trend determination of "unknown" was assigned. **5 Year Trend –** No PM_{10} monitoring data were available for the Basin after 2006 to determine a 5-year trend.

Confidence

Status – The data were collected continuously between 1989 and 2006 using federal reference methods (EPA 2011b), and the data was subject to extensive quality assurance requirements. However, insufficient data has been collected throughout each year over the past 5 years to determine the current status of annual average PM_{10} concentration. Thus, confidence in a current status determination is not applicable.

Long-term Trend – The confidence in the long-term trend for the analysis of 11 data points (1989 to 2006) of the annual average PM_{10} concentration is "moderate," with an S = -31, and a P = 0.01. However, because current data were not available between 2007 and 2011, confidence in the long-term trend is not applicable.

5 Year Trend – The trend over the most recent 5 years could not be determined because data were not available.

Overall Confidence – The overall confidence is not applicable (N/A) due to insufficient current status and trend data on annual average PM_{10} concentrations.

Interim Target – Because current data are not available, it is not possible to estimate an interim target.

Target Attainment Date – Because current data are not available, it is not possible to estimate a target attainment date.

Human & Environmental Drivers – Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of PM_{10} in the Lake Tahoe Basin are motor vehicles, paved and unpaved road dust, wood smoke, and construction dust. The ambient concentration of PM_{10} is dependent on meteorological conditions such as wind speed and atmospheric mixing.

Monitoring Approach – The monitoring record indicates that PM_{10} has been monitored at two locations in the Lake Tahoe Basin; Sandy Way in South Lake Tahoe, and at the casino core at Stateline, Nevada. Data from the Sandy Way site were collected, analyzed, and reported by the California Air Resources Board (CARB 2011a). Data from the Stateline, NV was collected, analyzed, and reported by the Nevada Division of Environmental Protection, and the U.S. Environmental Protection Agency.

Monitoring Partners – California Air Resources Board, Nevada Division of Environmental Protection U.S. Environmental Protection Agency, and Tahoe Regional Planning Agency

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards. The improving long-term trend for this indicator suggests that the programs and actions were effective at controlling concentrations of PM_{10} between 1989 and 2006.

Recommendations for Additional Actions – Reestablish sufficient monitoring of this indicator to improve the agency's ability to evaluate the indicator's status and trend. If monitoring results indicate non-compliance with Regional standards or a worsening trend, assess opportunities for additional policy and management actions. The existing TRPA Threshold Standards for wood smoke and suspended soil particles should be replaced with state or federal standards for PM_{10} because there is no established baseline.

Visibility: **3-year Average of the 98th percentile 24-hour $PM_{2.5}$ Concentration**

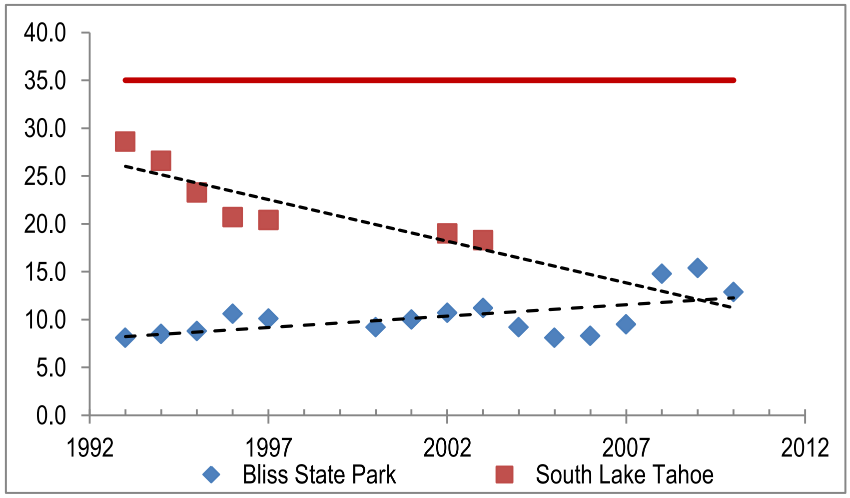
Reporting Icon	Trend

3-YEAR AVERAGE OF THE 98th PERCENTILE 24-HOUR $PM_{2.5}$ CONCENTRATION

Status: **Considerably Better than Target**

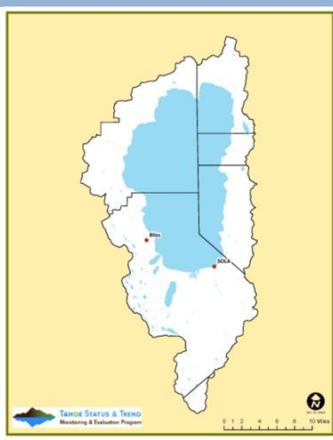
Trend: **Inconclusive**

Confidence: **Moderate**



The 3-year average of the 98th percentile 24-hour average concentration of particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) at Bliss State Park from 1993 through 2010, and at the South Lake Tahoe site from 1993 through 2003. These concentrations have been substantially better than the federal standard. The trend determination for this evaluation is based on currently available data from the Bliss site, indicating a "moderate decline" (or increasing concentration) of $PM_{2.5}$. However due to apparent declining (improving) trend at the South Lake Tahoe site – the overall trend determination was inconclusive.

Map



$PM_{2.5}$ monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – This indicator measures the 3-year running average of the 98th percentile 24-hour average concentration of $PM_{2.5}$. Particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) is extremely small and can be inhaled deep into the lungs causing or aggravating asthma, lung diseases, and heart disease. Some particles pass into the bloodstream and some are considered carcinogens. Federal standards have been adopted to protect the public from this pollutant.

Threshold Category – Air Quality

Indicator Reporting Category – Visibility

Adopted Standards – Federal: The 3-year average of the 98th percentile 24-hour $PM_{2.5}$ concentration must not exceed 35 $\mu g/m^3$.

Type of Standard – Numerical

Indicator – 3-year average of the 98th percentile 24-hour $PM_{2.5}$ concentration at any monitoring station ($\mu g/m^3$)

Status – The 3-year average of 98th percentile 24-hour $PM_{2.5}$ concentration for 2008-2010 at Bliss State Park was 12.9 $\mu g/m^3$ (IMPROVE 2011), which is 34% of the federal standard. Therefore, a status of "considerably better than target" is designated. Data for the South Lake Tahoe monitoring site has not been collected since 2003, and therefore it is not possible to characterize recent status from that location. According to the data record, the Region has never exceeded the federal standard.

Trend – Trends were calculated from available data using a Theil regression model (Theil 1950). **Long-term Trends -** The long-term trends for the South Lake Tahoe and Bliss State Park sites are not consistent over the monitoring record. For Bliss State Park, there is a long-term trend between 1991 and 2010 of gradually increasing 24 hour $PM_{2.5}$ concentrations at a rate of +0.27

μg/m^3 /year. This is equal to +0.77% per year of the federal standard of 35 μg/m^3. For South Lake Tahoe, there is a long-term trend between 1993 and 2003, of decreasing 24-hour $PM_{2.5}$ concentrations at a rate of -1.0 μg/m^3/year, or -2.9% per year change relative to the standard. The trend determination for this evaluation is based on currently available data from the Bliss site, indicating and "inconclusive" determination in $PM_{2.5}$ based on the gradual increase in indicator values at Bliss and decrease in values at the South Shore Site. **5 Year Trend –** The trend in the last 5 years (2006-2010) at Bliss State Park is not consistent with the long-term trend and indicates an increase in $PM_{2.5}$ concentration by +1.5 μg/m^3 /yr., or +4.3% of the standard per year. Note that short-term trends in air quality are typically not reliable due to the variability of meteorology from one year to the next.

Confidence

Status – There is moderate confidence in the determination for status. These sites used the IMPROVE sampler which is not a Federal Reference Method (FRM) $PM_{2.5}$ sampler, but is accepted for determining compliance with regional haze regulations. Data from the IMPROVE sample cannot be used to judge attainment of National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$. Consistent data from 1993 through 2009 is available for the Bliss State Park site. However, insufficient data has been collected in the past 6 years for the City of South Lake Tahoe site. There was extensive testing of the samplers, and rigorous quality control procedures employed at the measurement laboratories.

Long-term Trends – Based on the criteria established for determining confidence in trend for this report, the confidence in the current long-term trend at Bliss State Park for the analysis of 13 data points of the 3-year average 98th percentile 24 hour average concentration is high (P=0.04, S = 30). However, because the appropriate NAAQS $PM_{2.5}$ samplers (Federal Reference Methods) were not used, and there are gaps in current monitoring data at the City of South Lake Tahoe site the confidence rating is downgraded to "moderate". **5 Year Trend –** The confidence in the trend for the most recent 5 years (2005-2009) at Bliss State Park is "moderate," with a confidence level of 88%, an S = 6, and a P = 0.12. No 5-year trend could be estimated for the South Lake Tahoe site due to insufficient data. Overall confidence rating for trend is "moderate."

Overall Confidence – The overall confidence in the status and trend determination is "moderate," because of the "moderate" confidence rating for status, and "moderate" confidence rating for trend.

Interim Target – The Region is currently in attainment with this standard, and therefore it is not necessary to establish an interim target for this indicator.

Target Attainment date – The Region is currently in attainment with this standard, and therefore it is not necessary to establish a target attainment date for this indicator.

Human & Environmental Drivers - Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of $PM_{2.5}$ in the Lake Tahoe Basin are residential fuel combustion, wood smoke from wildfires and prescribed fires, motor vehicles, and paved and unpaved road dust. $PM_{2.5}$ results from primary emissions ($PM_{2.5}$ directly emitted from sources), condensation of semi-volatile organic gases, and from secondary formation from reactions of gases in the atmosphere (e.g. sulfate particles from sulfur dioxide emissions and reactions with other gases, nitrate particles from emissions mainly of nitrogen oxide, and reactions with other gases such as ammonia). Small particles are also transported into the Lake Tahoe Basin from distant locations, and the ambient concentration of $PM_{2.5}$ is highly dependent on meteorological conditions such as wind speed and mixing conditions.

Monitoring Approach – $PM_{2.5}$ is currently monitored at one site in the Lake Tahoe Region (Bliss State Park). This site is expected to be representative of background levels of $PM_{2.5}$ transported into the Lake Tahoe Basin, and has been in operation since 1990. Historical data (1989-2004) is available for South Lake Tahoe. The South Lake Tahoe site is expected to represent Basin-wide maximum $PM_{2.5}$ concentrations due to its relatively urbanized location. These sites used the IMPROVE sampler which is not a Federal Reference Method $PM_{2.5}$ sampler, but is accepted for determining compliance with regional haze regulations.

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), Tahoe Regional Planning Agency

Program and Action Implemented to Improve Conditions – Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards.

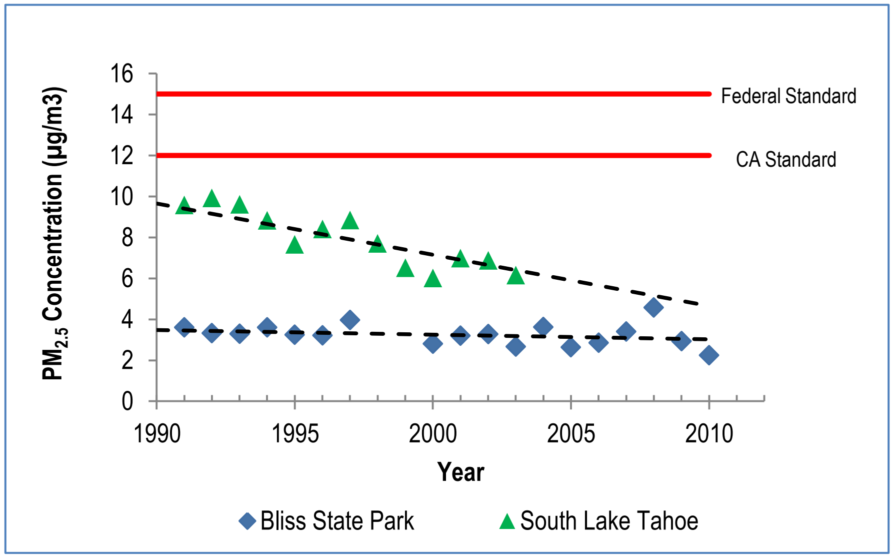
Effectiveness of Programs and Actions – The current status recorded at monitoring sites for this indicator suggests that programs and actions were effective at maintaining concentrations of $PM_{2.5}$ between 1993 and 2009, below the adopted standard. However, the very slight increasing trend at the Bliss site suggests that continued monitoring is needed and additional actions identified, if the trend continues to decline.

Recommendations for Additional Actions – Reestablish monitoring of this indicator in the South Lake Tahoe area to improve the agency's ability to evaluate the indicator's status and trend. Additionally, monitoring sites need to be appropriately equipped with NAAQS certified samplers in order to report certifiable particulate matter results. If monitoring indicates a worsening condition, assess opportunities for additional policy and management actions. Existing TRPA Threshold Standards for wood smoke and suspended soil particles should be replaced with state or federal standards for $PM_{2.5}$, because is there no established baseline for existing TRPA standards.

Visibility: **Annual Average $PM_{2.5}$ Concentration**

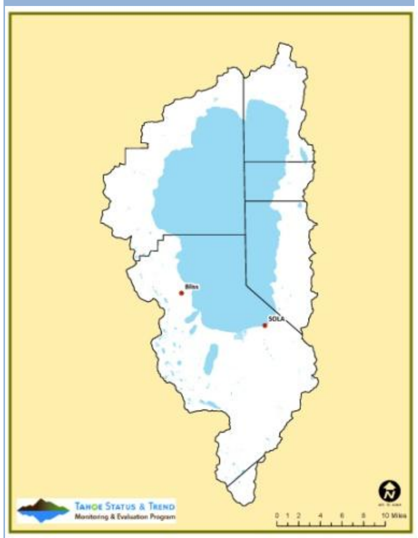
Status	Trend

ANNUAL AVERAGE
$PM_{2.5}$ CONCENTRATION
Status: **Considerably Better Than Target**
Trend: **Little or No Change**
Confidence: **Moderate**



The annual average concentrations of particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) measured at Bliss State Park and South Lake Tahoe monitoring sites from 1991 to 2010. Current concentrations are considerably better than federal and California standards. The long-term trend at each site shows decreasing annual average concentrations of $PM_{2.5}$.

Map



$PM_{2.5}$ monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

Relevance – This indicator addresses annual average $PM_{2.5}$ concentrations in the Lake Tahoe Region. Particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) is extremely small and can be inhaled deep into the lungs, causing or aggravating asthma, lung diseases, and heart disease. Some particles pass into the bloodstream and some are considered carcinogens. Federal and state standards have been adopted to protect human health.

Threshold Category – Air Quality

Threshold Indicator Category – Visibility

Adopted Standards – California: 12 $\mu g/m^3$ annual concentration must not be exceeded; Federal: 15 $\mu g/m^3$, 3-year average of weighted annual mean concentration must not be exceeded (not reported here); TRPA: No adopted standard; Nevada: No adopted standard

Type of Standard – Numerical

Indicator – Annual average $PM_{2.5}$ concentrations at any permanent monitoring station ($\mu g/m^3$)

Status – The 2010 annual average $PM_{2.5}$ concentration measured at Bliss State Park was 2.24 $\mu g/m^3$ (IMPROVE 2011). The 2010 annual average value was 18.7% of the most stringent California standard of 12 $\mu g/m^3$ (or 81.3% below target), resulting in a status determination of "considerably better than target."

Trend – Trends were calculated using the Theil regression method (Theil 1950). **Long-term Trends –** The long-term trends for South Lake Tahoe (1991 to 2003) and Bliss State Park (1991-2010) were decreasing in annual average $PM_{2.5}$ concentrations. The trend at the Bliss site is decreasing at a rate of -0.03 µg/m^3 /yr., or -0.3% per year relative to the most stringent California standard of 12 µg/m^3. The trend at the South Lake Tahoe monitoring site was decreasing at a more rapid rate of -0.31 µg/m^3 /yr., or -2.6%/yr. of the California standard. Because current data are insufficient (2004 to 2011) for the South Lake Tahoe Site, the Bliss site was used to characterize the regional annual average $PM_{2.5}$ concentration trend of "little or no change." The 5-year trend (2006-2010) at Bliss State Park indicates a decrease in annual average $PM_{2.5}$ concentration at a rate of -0.19 µg/m^3 /yr., or -1.6%/yr. of the California standard per year. Note that short-term trends in air quality are typically not reliable due to high inter-annual indicator variability, variability in meteorology and the small number of points evaluated (n=5).

Confidence

Status – There is "moderate" confidence in the status determination. IMPROVE samplers collected data at both monitoring sites, and used the IMPROVE sampling protocol which is not a Federal Reference Method (FRM) $PM_{2.5}$ sampler, but is accepted for determining compliance with regional haze regulations. Consistent data from 1993 through 2010 are available for the Bliss State Park site. However, insufficient data have been collected in the past 7 years for the South Lake Tahoe site, resulting in low confidence ranking. There was extensive testing of the samplers, and rigorous quality control procedures employed at the measurement laboratories.

Long-term Trends – The confidence in the long-term trend at Bliss State Park for the analysis of 18 data points (1991-2010) of the annual average $PM_{2.5}$ concentration is "high" with a confidence level of 93%, an S = -41, and a P = 0.07. The confidence in the long- term trend for the South Lake Tahoe site of 13 data points (1991-2003) is "low" for long term trend determination because of missing data between 2004 and 2011. For the time period of 1991 to 2003 at the South Lake Tahoe site, the confidence level is high with a S=-54 and a P < 0.01.

5 Year Trend – The confidence in the trend for the most recent 5 years (2006-2010) at Bliss State Park is "low," with a confidence level of 59%, an S = -2, and a P = 0.41.

Overall Confidence – The overall confidence in the status and trend is "moderate" because of the "moderate" confidence determination in both status and trend (long-term trend at the Bliss monitoring site).

Interim Target – The Region is currently in attainment with adopted standards, and therefore it is not necessary to identify an interim target.

Target Attainment Date – The Region is currently in attainment with adopted standards, and therefore it is not necessary to identify a target attainment date.

Human & Environmental Drivers – The primary sources of $PM_{2.5}$ in the Lake Tahoe Basin are residential fuel combustion, wood smoke from wildfires and prescribed fires, motor vehicles and paved and unpaved road dust. $PM_{2.5}$ results from both primary emissions ($PM_{2.5}$ directly emitted from sources) and from secondary formation from reactions of gases in the atmosphere (e.g. sulfate particles from sulfur dioxide emissions and reactions with other gases, nitrate particles from emissions mainly of nitrogen oxide and reactions with other gases such as ammonia), and condensation of semi-volatile organic gases. Small particles are also transported into the Lake Tahoe Basin from distant locations, and the ambient concentration of $PM_{2.5}$ is highly dependent on meteorological conditions such as wind speed, and mixing conditions.

Monitoring Approach – $PM_{2.5}$ is currently monitored at one site in the Lake Tahoe Basin (Bliss State Park). This site is expected to be representative of background levels of $PM_{2.5}$ transported into the Lake Tahoe Basin and has been in operation since 1990. Historical data (1989-2004) are available for South Lake Tahoe. The South Lake Tahoe site is expected to represent basin-wide highest $PM_{2.5}$ concentrations because it is located in a relatively densely populated urban area. These sites used the IMPROVE sampler, which is not a Federal Reference Method $PM_{2.5}$ sampler but is accepted for determining compliance with regional haze regulations.

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), Tahoe Regional Planning Agency

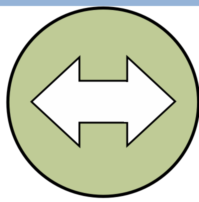
Program and Action Implemented to Improve Conditions – Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The current status, and stable and declining trend recorded at the Bliss monitoring site for this indicator suggest the programs and actions were effective at controlling concentrations of $PM_{2.5}$ between 1993 and 2010. However, it is unknown if programs and action were effective at the sub-regional scale because data were incomplete for the South Lake Tahoe site from 2004 to current.

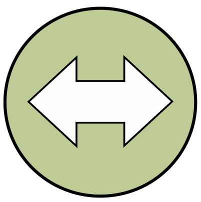
Recommendations for Additional Actions – Reestablish monitoring of this indicator at the South Lake Tahoe area to improve the agency's capability to evaluate the indicator's status and trend. Additionally, monitoring sites need to be appropriately equipped with NAAQS certified samplers in order to report certifiable particulate matter results. If monitoring indicates worsening conditions, assess opportunities for additional policy and management actions. The existing TRPA Threshold Standards for wood smoke and suspended soil particles should be replaced with state and/or federal $PM_{2.5}$ concentration standards because there are no established baselines for existing TRPA standards.

Visibility: **Regional Visibility**

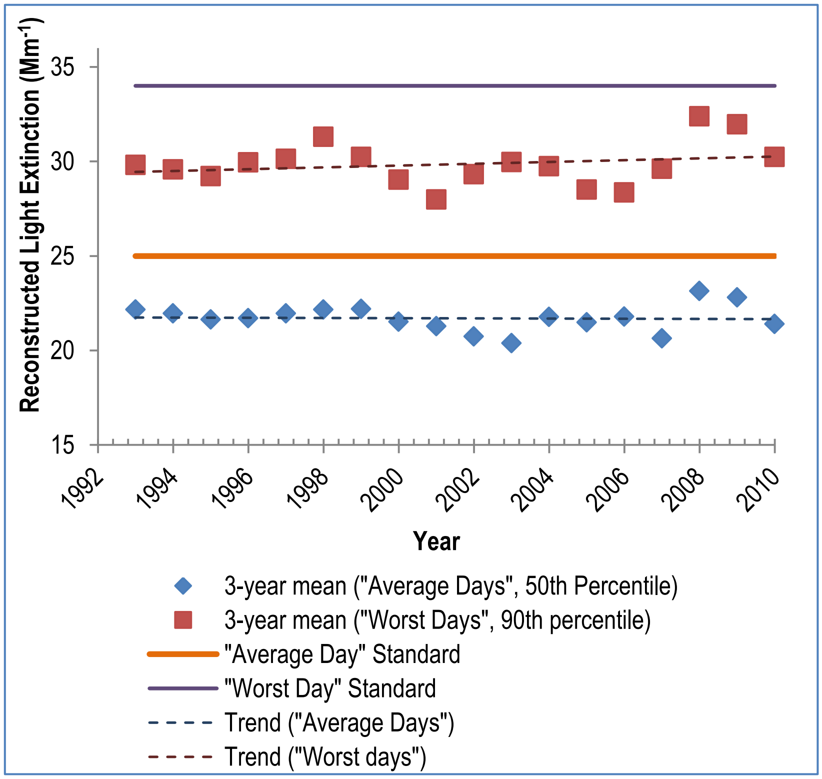
Reporting Icon	Trend



REGIONAL VISIBILITY
50th PERCENTILE
Status: **At or Somewhat Better than Target**
Trend: **Little or no change**
Confidence: **Moderate**

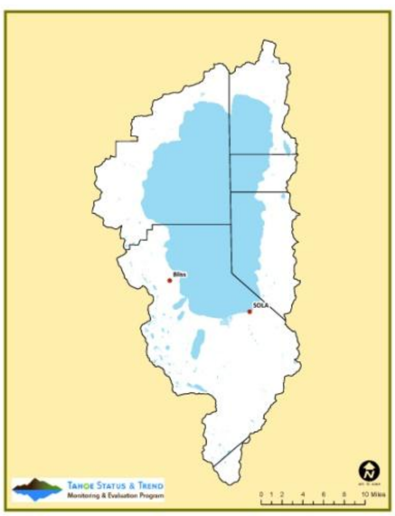


REGIONAL VISIBILITY
90th PERCENTILE
Status: **At or Somewhat Better than Target**
Trend: **Little or no change**
Confidence: **Moderate**



Regional visibility conditions were monitored at the Bliss IMPROVE monitoring station (western portion of the Basin) from 1991 through 2010 using the 3-year running average reconstructed light extinction (b_{ext}) indicator. Light extinction measures the amount of absorption and dispersion of light in the atmosphere. The Tahoe Region is currently meeting adopted regional Visibility Threshold Standards for the 3-year running average indicator and has throughout the monitoring record. Trends for both “average days” (50th Percentile) and “worst day” (90th percentile) exhibit “little or no change.” Wildfires occurring within (e.g., 2007 Angora Fire) and outside of the Tahoe Region likely contributed to increases in light extinction 3-year mean values measured in 2008 and 2009 (Chen et al. 2011).

Map



Lake Tahoe visibility monitoring locations (Bliss State Park was used for Regional measurements and South Lake Tahoe (SOLA) was used for sub-regional measurements).

Data Evaluation and Interpretation

Relevance – This indicator measures regional visibility or the distance that the human eye can see. It is measured by using a reconstructed light extinction (b_{ext}) value, which is derived from an equation that combines measured concentrations of several gasses and particles. The equation is corrected for humidity and natural "background" light scattering. B_{ext} is summarized by "average visibility days" (50^{th} percentile values) and "worst visibility days" (90^{th} percentile values) for each year, followed by calculating the 3-year running average. This Threshold Standard has been adopted to protect regional visibility and air quality.

Threshold Category – Air Quality

Threshold Indicator Reporting Category - Visibility

Adopted Standards – TRPA: 1) Achieve an extinction coefficient of 25 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 156 kilometer (97 miles)), and 2) Achieve an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 115 kilometers (71 miles)). Calculations will be made on three year running periods, beginning with the existing 1991-93 monitoring data as the performance standards to be met or exceeded.

Type of Standard – Numerical

Indicator – 3-year running average of the reconstructed light-extinction (Mm^{-1}, "inverse mega meters") from data collected at the Bliss Monitoring Site.[5]

Status – The most recent data for annual average visibility from 2010 shows that "average visibility days" are 17.4 Mm^{-1}, and "worst visibility days" are 27.7 Mm^{-1} for the Region (as measured at the Bliss IMPROVE monitoring site). The most recent data for the 3-year average visibility from 2008 to 2010 show that "average visibility days" were 21.4 Mm^{-1}, and "worst visibility days" were 30.2 Mm^{-1}. The most recent 3-year running average values for "average visibility days" were 14% better than the regional 50th percentile standard of 25 Mm^{-1}, resulting in a determination of "at or somewhat better than the target." Current 3-year running average values for "worst days" were 11% better than the regional 90^{th} percentile standard, resulting in a determination of "at or somewhat better than target." According to the monitoring record, the Region has been in compliance with regional standards for "average days" and "worst days" in all years. Decreases in visibility occurring in 2008, 2009 and 2010 3-year running average values, were attributed to wildfires occurring outside of the Lake Tahoe Region; more than 2.3 million acres were consumed by wildfire in California according to Chen et al. (2011) and the CAL Fire incident database (http://cdfdata.fire.ca.gov/incidents/incidents).

Trend – A Theil regression analysis was used to determine trend for regional visibility indicators (Theil 1950). There was "little or no change" in the long-term (1991-2010) trend of regional "average visibility days" (50^{th} percentile values; Slope = 0.021, S-value = -11, P=0.358) and for "worst visibility days" (90^{th} percentile; Slope = 0.057, S-value = 26, P = 0.154). The uptick in the regional "worst visibility day" 3-year mean values was attributed to smoke generated as a result of greater than 2.3 million acres of wildfire recorded in 2007 and 2008 throughout California (CALFIRE 2011, Chen et al. 2011).

Confidence

Status – There is high confidence in the determination of regional visibility conditions because current b_{ext} data were compared with optical measurements from 1999-2003, and showed a good correspondence (Chen et al. 2011). Results of the Lake Tahoe Atmospheric Deposition Study (CARB 2006), and satellite remote sensors, confirmed that the location of the regional monitoring site (D.L. Bliss State Park) was representative of visibility conditions for the Tahoe Basin (DRI 2011a). B_{ext} data are also collected using the IMPROVE national protocol that has been reviewed extensively.

Trend – Trend in average visibility was determined to be "moderate" because the regression analysis indicated a moderate probability that the trend test result occurred by chance for both average days and worst days (P=0.358 and P = 0.154, respectively).

Overall – The overall confidence for both the "average visibility day" and "worst days" status and trend was "moderate" due to the moderate confidence assign to trend.

Interim Target – No interim target was identified because the Region is currently in attainment with the standard.

Target Attainment Date – No attainment date was identified because the Region is currently in attainment with the standard.

Human and Environmental Drivers – Particulate matter in the atmosphere is the primary driver of visibility impairment because of the optical properties and long retention times in the air (Green et al. 2011). The main sources of particulate matter in the Basin are residential and wildfire smoke, and entrained roadway dust (DRI 2011a). Effective motor vehicle tail pipe emission controls,

[5] Calculated: $b_{ext} = b_{scat} + b_{abs} = b_{sg} + b_{sp} + b_{ag} + b_{ap}$. Where, b_{scat} is the sum of scattering by gases and scattering by particles, and b_{abs} is the sum of absorption by gases and particles. Scattering by gases in the atmosphere, b_{sg}, is described by the Rayleigh scattering theory (a standard value of 9 Mm^{-1}). Scattering by particles, b_{sp}, is caused by both fine and coarse aerosol species. Absorption due to gases, b_{ag}, is primarily due to nitrogen dioxide (NO_2) and is assumed to be negligible in rural locations. Absorption by particles, b_{ap}, is caused primarily by carbon containing particles.

residential wood combustion controls, appropriately managed prescribed burning, and road dust emission control would aid in improving regional visibility conditions (DRI 2011a). There is uncertainty related to visibility condition in the future due to predicted increases in frequency and intensity of wildfires in the western U.S. (DRI 2011a).

Monitoring Approach – Air samples needed to calculate b_{ext} were collected at least every 6 days at D.L. Bliss State Park. This is an appropriate site for monitoring regional conditions because it is not influenced by urban sources (DRI 2011a). Data are collected, analyzed, and reported by the IMPROVE (national Interagency Monitoring of Protected Environments) network using nationally accepted protocols.

Monitoring Partners – U.S. Forest Service, UC Davis, US National Park Services and Colorado State University.

Program and Action Implemented to Improve Conditions - Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs, state and federal vehicle emission standards.

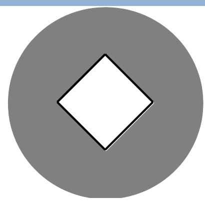
Effectiveness of Programs and Actions – The improving long-term trend for "average visibility days" suggests that the programs and actions were effective at maintaining and improving visibility between 1991 and 2009. Wildfires from outside of the Basin appear to negatively influence visibility conditions in the Region; the agency has no ability to regulate or otherwise control this source of visibility impairment. Prescribed burning (i.e., burn days) should continue to be regulated by appropriate state authorities.

Recommendations for Additional Actions – Existing strategies appear to be effective considering the status of these indicators relative to adopted standards. Continue to monitor and make necessary adjustments to control programs as appropriate. The relatively new federal Clean Air Visibility Rule[6] and results from Chen et al. (2011), indicate that TRPA should consider an update to Regional Visibility Threshold Standards.

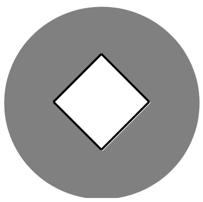
[6] *http://www.epa.gov/visibility/fs_2005_6_15.html*

Visibility: **Sub-Regional Visibility**

Reporting Icon

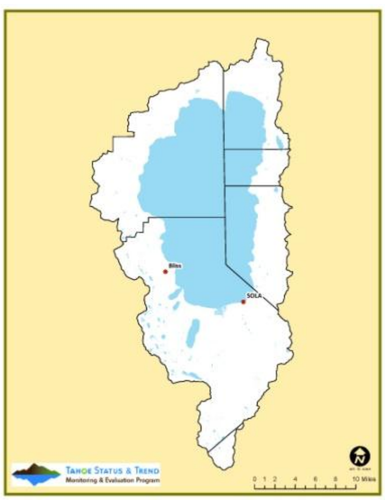


SUB-REGIONAL VISIBILITY
50th PERCENTILE
Status: **Unknown**
Trend: **Unknown**
Confidence: **N/A**



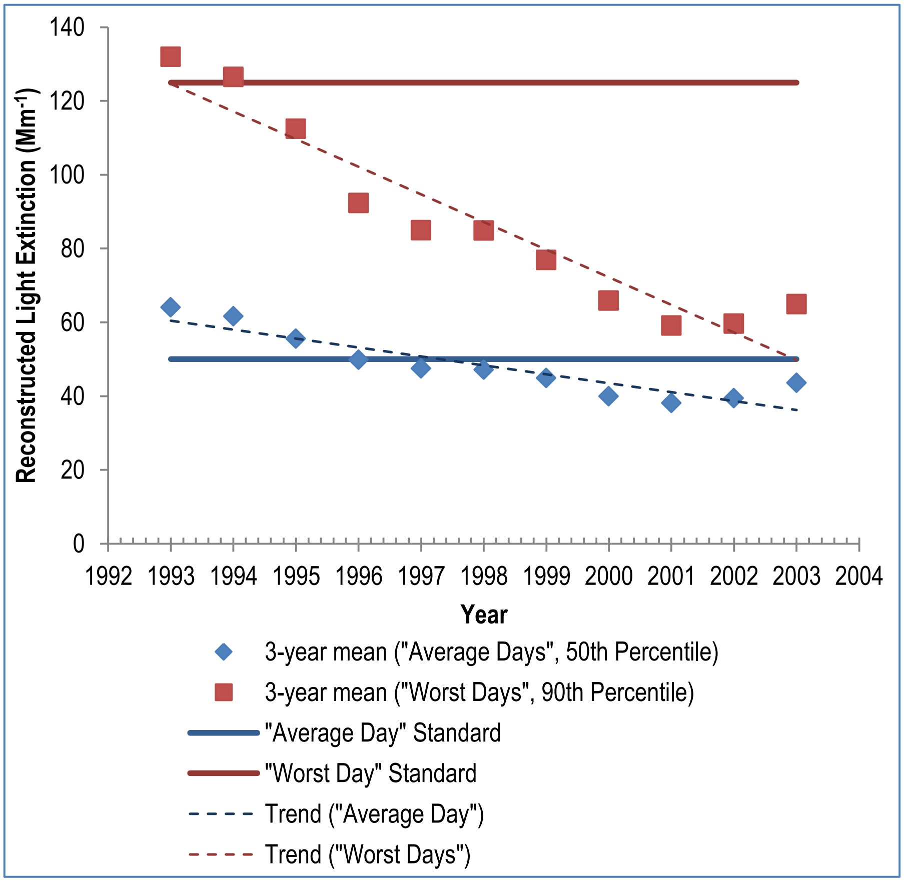
SUB-REGIONAL VISIBILITY
90th PERCENTILE
Status: **Unknown**
Trend: **Unknown**
Confidence: **N/A**

Map



Visibility monitoring stations in the Lake Tahoe Region. The SOLA monitoring site, located In the southern portion of the Lake, was used to characterize sub-regional visibility conditions from 1991 to 2003.

Trend



Sub-regional visibility conditions were monitored at the South Lake Tahoe monitoring station (southern urbanized portion of the Region) from 1991 through 2003 using the 3-year running average reconstructed light extinction (b_{ext}) indicator. Light extinction measures the amount of absorption and dispersion of light in the atmosphere. Recent sub-regional visibility data were insufficient to determine current status and trends for the 3-year running average indicator. Prior to 2004, trends for both "average days" and "worst days" indicators showed moderate to rapid improvement ($P<0.01$).

Data Evaluation and Interpretation

Relevance – This indicator measures sub-regional visibility in South Lake Tahoe, or the distance that the human eye can see. It is measured by using a reconstructed light extinction (b_{ext}) value, which is derived from an equation that combines measured concentrations of several gasses and particles. The equation is corrected for humidity and natural “background” light scattering. B_{ext} is summarized by “average visibility days” (50th percentile values) and “worst visibility days” (90th percentile values) for each year followed by calculating the 3-year running average. This Threshold Standard has been adopted to protect sub-regional visibility and air quality.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Visibility

Adopted Standards – TRPA: 1) Achieve an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 78 kilometers, 48 miles), and 2) Achieve an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the Sou Lake Tahoe monitoring site (visual range of 31 kilometers, 19 miles)

Type of Standard – Numerical

Indicator – 3-year running average of the reconstructed light-extinction (Mm^{-1}, “inverse mega meters”) from data collected at the SOLA monitoring site.[7]

Status – Due to insufficient data the current status is “unknown” for both “average visibility days” and “worst visibility days” at the sub-regional scale. Historical annual average data from 2003 showed that “average visibility days” were 42.62 Mm^{-1} and “worst visibility days” were 72.73 Mm^{-1} at the sub-regional scale. The 3-year running average for 2003 showed that “average visibility days” were 43.55 Mm^{-1} and “worst visibility days” were 64.89 Mm^{-1} at the sub-regional scale. The most recent 3-year running average values (2003) for “average visibility days” were 12.9% better than the regional 50th percentile standard of 50 Mm^{-1} resulting in a determination of “somewhat better than the target.” The most recent 3-year running average values (2003) for “worst days” were 48% better than the regional 90th percentile standard resulting in a determination of “considerably better than target.” According to the monitoring record, the Region has been in compliance with regional standards for “average days” and “worst days” since 1996.

Trend – Due to insufficient data, a current trend determination was not possible and therefore classified as “unknown.” A Theil regression (Theil 1950) analysis was used to determine trends for the sub-regional 3-year running average visibility indicator prior to 2004. The estimated trend for the 3-year running average of the historical “average visibility days” data (1991-2003) for reconstructed light extinction was improving (less light extinction) at a rate of 4.47%/year ($P<0.01$) indicating a “rapid improvement.” The trend for the 3-year running average estimated for “worst visibility days” based on historical data (1991-2003) was improving at a rate of 6%/year also indicating a “rapid improvement” ($P<0.01$).

Confidence – Because of insufficient data for 2004 to 2010, confidence in the determination of status and trends was “N/A” (not applicable).

Interim Target – Unable to establish interim target due to insufficient data. Data available between 1991 and 2003 indicated that the Region was in attainment with the Threshold Standard.

Target Attainment Date – Unable to establish attainment date due to insufficient data. Data available between 1991 and 2003 indicated that the Region was in attainment with the Threshold Standard.

Human and Environmental Drivers – Particulate matter in the atmosphere is the primary driver of visibility impairment because of the optical properties and long retention times in the air (Green et al. 2011). The main sources of particulate matter in the basin are smoke and entrained roadway dust (DRI 2011a). Improving visibility trends are attributable to effective controls over motor vehicle, residential wood combustion, regulatory controls over prescribe burn (burn days) and road dust emissions (DRI 2011a). The most substantial risk and uncertainty related to visibility is the increased frequency and intensity of wildfires in the western U.S. (DRI 2011a).

Monitoring Approach – Air samples needed to calculate b_{ext} were collected at least every 6 days a South Lake Tahoe site. Data were collected, analyzed and reported by the IMPROVE (national Interagency Monitoring of Protected Environments) network using nationally accepted protocols. Re-establishing a sub-regional site in South Lake Tahoe is the top priority of a future visibility monitoring program.

Monitoring Partners – USDA Forest Service, UC Davis, US National Park Services and Colorado State University.

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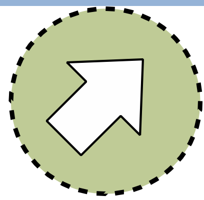
[7] *Calculated: $b_{ext} = b_{scat}+b_{abs} = b_{sg}+b_{sp}+b_{ag}+b_{ap}$. Where, b_{scat} is the sum of scattering by gases and scattering by particles, and b_{abs} is the sum of absorption by gases and particles. Scattering by gases in the atmosphere, b_{sg}, is described by the Rayleigh scattering theory (a standard value of 9 Mm^{-1}). Scattering by particles, b_{sp}, is caused by both fine and coarse aerosol species. Absorption due to gases, b_{ag}, is primarily due to nitrogen dioxide (NO_2) and is assumed to be negligible in rural locations. Absorption by particles, b_{ap}, is caused primarily by carbon containing particles.*

Program and Action Implemented to Improve Conditions - Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs, state and federal vehicle emission standards and programs.
Effectiveness of Programs and Actions – Historical trends for "average visibility days" and "worst visibility days" suggest that programs and actions were effective at maintaining and improving visibility between 1991 and 2003.
Recommendations for Additional Actions – It is recommended that existing sources of airborne particles continue to be controlled. For example, the agency should continue to require that EPA certified woodstoves be installed in residences (in place of non-compliant wood stoves and fireplaces), encourage residents to use alternative heat sources (e.g., natural gas) other than firewood to warm homes, continue controls on prescribed burning (i.e., burn days), control entrained road dust by not applying excess traction sands and salts, and encourage transportation departments to conduct regular street sweeping using the latest high efficiency street sweeping technologies. The South Lake Tahoe monitoring site (SOLA) was decommissioned in 2004 as a result of the property being sold. It is recommended that the agency reestablish monitoring of this indicator in the same vicinity to improve the agency's capability of evaluating the status and trends of sub-regional visibility conditions. If monitoring results indicate a worsening condition, assess opportunities for additional policy and management actions.

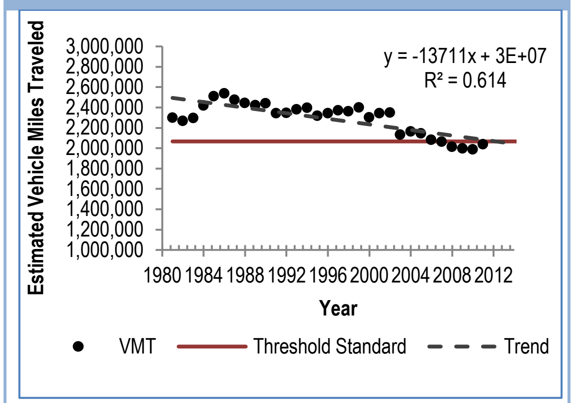
Visibility: **Vehicle Miles Traveled**

Reporting Icon	Map



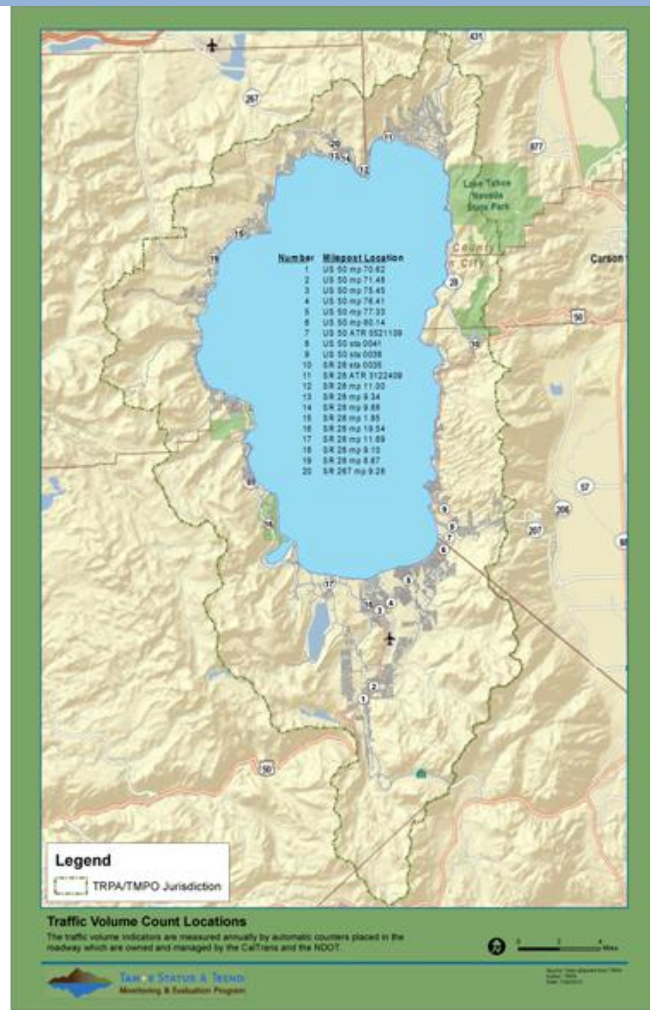
VEHICLE MILES TRAVELED
Status: **At or Somewhat Better than Target**
Trend: **Moderate Improvement**
Confidence: **Low**

Trend



Estimated annual daily vehicle miles traveled based on the TRPA TransCAD Transportation Model, and average annual daily vehicle counts from a peak travel day (2nd weekend in August) of each calendar year in the Lake Tahoe Basin 1981 to 2011. Source: TRPA Transportation Department, CalTrans and NDOT.

Map



Locations of traffic volume monitoring sites in the Lake Tahoe Region.

Data Evaluation and Interpretation

Relevance – Vehicle Miles Traveled (VMT) is a proxy measure of traffic congestion, the production of nitrates, and entrainment of soil sediments from roads. Historically, TRPA posited that more VMT would result in increased traffic congestion, increased nitrate loading into the atmosphere (and subsequent deposition into Lake Tahoe), and an increase in the airborne concentration of particulate matter known to impact regional and sub-regional visibility and human health (TRPA 1982b).
Threshold Category – Air Quality
Threshold Indicator Reporting Category – Visibility and Nitrate Deposition
Adopted Standards – TRPA: Reduce vehicle miles traveled in the Basin by 10% of the 1981 base year values (equivalent to 2,067,600 VMT).
Type of Standard – TRPA: Listed as a Numerical Standard for the Visibility Indicator Reporting Category, and as a Management Standard with a numeric target for the Nitrate Deposition Indicator Reporting Category.
Indicator – Peak day vehicle miles traveled (VMT). The most recent vehicle miles traveled was estimated for 2010 using a sophisticated transportation model (TransCAD). Because transportation models have changed over time, VMT estimates are not comparable across years. To characterize the status and trends of the VMT in the Region (1981 to 2011), the ratio between the 2010 modeled VMT (using TransCAD model) and peak daily traffic volume (measured in the 2nd weekend in August) was used. This ratio (or constant) was calculated as follows: ratio (constant) = 2010 modeled VMT value/peak traffic volume measured during the 2nd weekend

in August in 2010. The resulting constant was multiplied by peak traffic volume measured during the 2nd weekend in August of each year (1981 to 2009) to estimate annual peak day VMT values. The constant assumes that all VMT model inputs (e.g., number of vehicle occupants, distance traveled) have remained constant between 1981 and 2010. A total of 20 traffic monitoring sites operated by California Department of Transportation (Caltrans) and Nevada Department of Transportation (NDOT) were used to estimate annual peak day traffic volumes.

Status – The most recent vehicle miles traveled estimate (2011) was 2,036,642 VMT per day or about 1.5% better than the standard, resulting in an "at or somewhat better than target" status determination. The Tahoe Region has been in compliance with this standard since 2007.

Trend – The estimated long-term (1981-2011) trend shows a decrease in daily VMT in the Tahoe Basin, at rate of -13,711 VMT/peak day/year (or -0.66%/year) relative to the standard ($P<0.01$), resulting in a trend determination of "moderate improvement."

Confidence – The confidence in VMT status and trend was determined to be "low." Since 1981, the TRPA has used a series of progressively more sophisticated models to estimate VMT. As the VMT models improved, current day VMT model estimate comparisons with previous year VMT model estimates were not possible because different parameters were used for different VMT models, and mapped traffic zones have changed over time. Holding other input parameters constant assumes that no change has occurred in those parameters since 1981 (TMPO 2008). As a result, overall confidence in the status and trend determination is "low," as is it unknown how input parameter values have changed over time.

Interim Target – The Region is currently in attainment with this standard, and therefore it is not necessary to establish an interim target.

Target Attainment Date – The Region is currently in attainment with this standard, and therefore it is not necessary to establish a target attainment date.

Human and Environmental Drivers – Variation in VMT is primarily a function of economic conditions (e.g., gas prices, unemployment rates, and secondary home ownership). Increasing access to transit services, access to bicycle and pedestrian facilities, and the relative desirability of alternative modes of transportation in comparison to the use of the personal automobile can also assist in reducing VMT.

Monitoring Approach – VMT presented here is an estimated number based on peak daily traffic volumes from the 2nd weekend of August each year. Traffic volume data are collected daily at 20 monitoring stations in the Tahoe Basin by California Department of Transportation (Caltrans) and Nevada Department of Transportation. Peak traffic volumes were multiplied by a VMT constant (4.77) that represents average number of trips per person per day, average trip length, and average vehicle occupancy to provide an estimate of daily VMT.

Monitoring Partners – TRPA, Caltrans, and the Nevada Department of Transportation (NDOT).

Program and Action Implemented to Improve Conditions - Public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs and transportation improvement projects (e.g., Heavenly Gondola project).

Effectiveness of Programs and Actions – The status and trend in estimated VMT suggest that existing transportation programs and projects and the sagging economic conditions may have resulted in effectively reducing VMT.

Recommendations for Additional Actions – The original supposition that there is a relationship between VMT and air and water pollutant loads needs to be further evaluated. For example, the question of what level of VMT needs to be maintained in order to avoid excessive loading of nitrate to Lake Tahoe, should be addressed by research. Alternatively, consider revising the VMT Threshold Standard to better measure the use alternative modes of transportation.

Nitrate Deposition

Nearly 78 percent of the air we breathe is nitrogen gas (N_2). Atmospheric N_2 is converted to nitrogen oxide by lightning, sunlight, and fossil fuel and biomass combustion. Industrial emissions and fossil fuel combustion contribute gaseous nitrous oxides and nitrate (as nitric acid) from sources sometimes hundreds of miles away. Excessive nitrate discharge into the air and subsequent deposition into water can negatively impact water quality. Atmospheric sources of biologically available forms of nitrogen have been linked to declines in Lake transparency because different forms, such as nitrate and ammonium, provide nutrients for attached and free-floating algae (TERC 2011a). Another nutrient of concern is phosphorous, which is found in the air in particulate form, but has not been identified as a significant atmospheric source of Lake transparency degradation (Lahontan 2010). Because both gaseous nitric acid and particulate ammonium nitrate particles are small (less than 2.5 microns in diameter), they do not easily settle out of air. For this reason, they have also been linked to decreased visibility within the Basin.

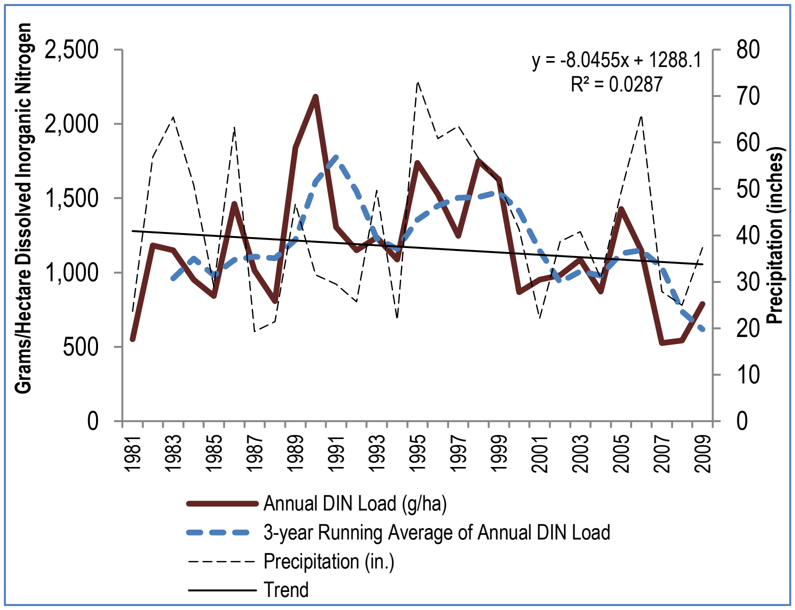
Management Standard Summary: **Nitrate Deposition**

Reporting Icon	Trend

I

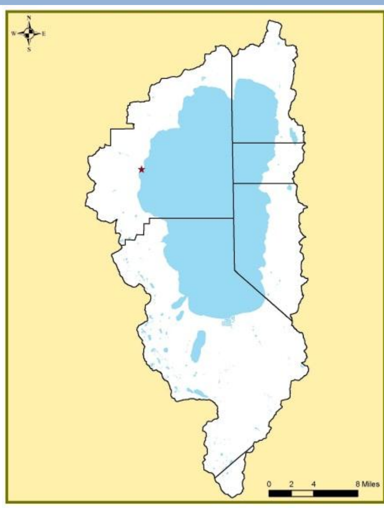
Status: **Implemented**

Trend



Estimated annual dissolved inorganic nitrogen load (grams/hectare) from precipitation (rain and snow), and 3-year running average of annual loads of dissolved inorganic nitrogen from precipitation, relative to precipitation levels measured at Ward Creek monitoring site from 1981 to 2009 (TERC 2011b). Converted to metric tons, annual DIN load from rain and snow ranged from about 26 metric tons in 2007, to 108 metric tons in 1990. The most current estimate for 2010 is 59 metric tons, which is just below the upper annual DIN loading estimate (from precipitation and dry deposition) provided in TRPA (1982a) for the years between 1973 and 1981.

Map



Generalized location of Ward Creek nutrient deposition monitoring (red star). Source: UC Davis (TERC).

Data Evaluation and Interpretation

Relevance – Excessive nitrate discharge into the air and subsequent deposition into water can negatively impact air quality and water quality. Atmospheric sources of biologically available forms of nitrogen have been linked to declines in Lake transparency because different forms, such as nitrate and ammonium, provide nutrients for attached and free-floating algae (TERC 2011a). Because both gaseous nitric acid and particulate ammonium nitrate particles are small (less than 2.5 microns in diameter), they do not easily settle out of the air or water. For this reason, they have also been linked to decreased visibility within the Basin.

Threshold Category – Air Quality and Water Quality

Threshold Indicator Reporting Category –Nitrate Deposition, Pelagic Lake Tahoe and Littoral Lake Tahoe

Adopted Standards – Two inter-connected management standards were adopted by TRPA that address nitrate deposition, one under the Air Quality Threshold Category, and one under the Water Quality Threshold Category. The Air Quality Threshold Standard states: "*Reduce the transport of nitrates into the Basin and reduce oxides of nitrogen (NOx) produced in the Basin consistent with the water quality thresholds.*" The Threshold Standard under the Water Quality Threshold Category is a Management Standard with a numeric target that states: "*Reduction in direct dissolved inorganic nitrogen (DIN) load on Lake Tahoe from atmospheric sources by approximately 20 percent of the 1973-1981 annual average.*" The annual average loading level for dissolved inorganic nitrogen from the 1973 to 1981 was estimated at 40 to 66 metric tons/year (TRPA 1982a); the accuracy of this estimate was not validated, thus, it is not a reliable target to assess attainment status.

Type of Standard – TRPA: Management Standard

Indicator – Attainment of the management standards was evaluated using the following two criteria:

- Has the TRPA (and/or other agencies) adopted sufficient policies, ordinances, and programs in support of the management standards?
- Is there empirical evidence that demonstrates a reduction in nitrogen deposition into Lake Tahoe?

Status – Policies, ordinances and environmental improvements have been implemented. However, their effectiveness could not be demonstrated with available information. The TRPA has adopted several policies to encourage reduction in air and water pollutants, including sources of nitrate and dissolved inorganic nitrogen deposition into Lake Tahoe. For air quality, TRPA has adopted several policies (TRPA 1986; TRPA 1992) that support the use of alternative modes of transportation to reduce atmospheric sources of air pollutants such as nitrate (e.g., postal delivery, waterborne transportation, public transportation and bicycle and pedestrian facilities). The *Code of Ordinances,* Chapter 93, includes regulations requiring that combustion appliances and wood heaters meet emission standards. The *Code of Ordinances* also requires that potential air quality impacts from a project be addressed as a component of the environmental documentation and permitting process (see Chapters 5 and 6).

For sources of nitrogen pollution associated with surface and groundwater, TRPA has adopted policies and ordinances to reduce nitrogen loads into Lake Tahoe (TRPA 1986). For example, TRPA requires that stormwater is infiltrated (treated) on-site for each developed parcel in the Basin. New initiatives, such as the Lake Tahoe Total Daily Maximum Load (TMDL) program administered by the states of Nevada and California, may require local jurisdictions to demonstrate pollutant load reductions from various sources, including atmospheric sources. The Environmental Improvement Program (EIP) administered by the TRPA, in partnership with state, federal, and local governments has facilitated a number of projects that were designed to aid in achieving this standard. Numerous projects under the EIP, such as bicycle trails and the Heavenly Gondola Project, have been implemented to reduce dependency on private automobiles, and thus, reduce pollutant loads to Lake Tahoe.

The California Air Resources Board and US Environmental Protection Agency continue to require vehicle manufacturers to equip new cars with sophisticated emission control systems. These systems generally include a “three-way” catalyst (which converts carbon monoxide and hydrocarbons to carbon dioxide and water, and also helps to reduce nitrogen oxides to elemental nitrogen and oxygen), and are equipped with an on-board computer and oxygen sensor to control tailpipe emissions[8].

Available data from UC Davis – Tahoe Environmental Research Center (TERC) showed that annual nitrogen (DIN) loads from precipitation (rain and snow) vary considerably over the monitoring record from year to year (range 26 to 108 metric tons/year), and loading appears closely related to the amount of precipitation received in any one year. A simple linear regression analysis on atmospheric DIN load revealed that the trend for DIN loading from rain and snow was decreasing at a rate of -8.05 grams/hectare/year. However, the trend was not significant ($r^2 = 0.029$, $P = 0.379$). This result was likely due to high inter-annual variation in DIN load and the effect of precipitation. According to TERC (2011a), the nitrogen load in 2010 was relatively close to the long-term averages (about 1,200 grams/hectare or 59 metric tons), representing an increase over previous years (2007-2009). Consequently, available empirical evidence suggests there has been little or no change in atmospheric DIN deposition into Lake Tahoe. However, empirical evidence demonstrated that there has not been an increase in nitrate deposition and that at minimum, existing control measures have maintained nitrate deposition into Lake Tahoe.

Interim Target – TRPA and other agencies have implemented actions to reduce nitrogen-related pollutants, and thus, the Region is currently in attainment with this standard. It is not necessary to establish an interim target.

Target Attainment Date – TRPA and other agencies have implemented actions to reduce nitrogen-related pollutants, and thus, the Region is currently in attainment with this standard. It is not necessary to establish a target attainment date.

Human and Environmental Drivers – Natural sources of oxides of nitrogen, nitrate, and dissolved inorganic nitrogen include wildfire and transformation of nitrogen, resulting from sunlight and electrical storms. Human-generated sources include the combustion of fossil fuels (e.g., vehicle emissions), fertilizers, and industrial emissions (from outside of the Basin).

Management Partners – California Air Resources Board, Nevada Division of Environmental Protection, US Environmental Protection Agency, Local Air Quality Management Districts (Washoe County, El Dorado County, Placer County).

Program and Action Implemented to Improve Conditions – Federal and state vehicle emission standards, state and local restrictions on open burning, TRPA policies and ordinances on land use, alternative fuels, postal service delivery, wood stove and gas-fired appliances, bicycle and pedestrian facilities, and public transit.

Effectiveness of Programs and Actions – Available information from the UC Davis (TERC) nutrient deposition monitoring efforts at Ward Creek suggests there has been little or no statistical change in the amount of dissolved inorganic nitrogen (which include nitrate) deposited into Lake Tahoe annually, since the adoption of the *Regional Plan* and stricter vehicle federal and state emission standards and requirements.

Recommendations for Additional Actions – As with all non-numeric Management Standards and Policy Statements, it is difficult to objectively determine “attainment” status. It is recommended that both standards be reviewed and amended, or corrected, to improve the agency’s ability to objectively determine attainment status. Consideration should be given to developing monitoring efforts as part of the Lake Tahoe TMDL program to measure the status and trend of atmospheric loading of pollutants to Lake Tahoe because currently, data from only one location is measured and reported. Available monitoring information

[8] http://www.epa.gov/otaq/standards/index.htm, http://www.arb.ca.gov/msprog/levprog/levii/ levii.htm

suggests that actions that have been implemented thus far have not statistically reduced the amount of DIN load deposited into Lake Tahoe from atmospheric sources. According to Alan Gertler (2011 personal communication, Desert Research Institute), there are several outstanding questions regarding nitrate deposition and its dynamics in the Lake Tahoe Region. Gertler emphasizes that no one has estimated the total amount falling on the Lake Tahoe Basin landscape; the estimates of nitrate deposition only consider what falls directly onto the Lake at one monitoring location. The total nitrate load to the Lake is the sum of the amount falling directly onto the Lake plus some fraction of the amount falling onto the watershed. Research is needed to better estimate the total nitrate load to the entire Basin, and what fraction contributes to Lake degradation. Notwithstanding these information gaps, recommended policy and management action include additional consideration for implementing measures to reduce atmospheric sources of nitrates.

Odor

Relevance – Air quality conditions in the Lake Tahoe Basin can affect human health, visibility, forest health, and the clarity of Lake Tahoe. One of the primary factors influencing these conditions has been identified as motor vehicle emissions. In an effort to address environmental and human health concerns from vehicle emissions, specifically fumes attributed to diesel engines, ordinances that regulate motor vehicle "odor" in the Basin were adopted by the TRPA in 1987. According to the Odor Policy Statement, "...*it is a policy of the TRPA Governing Board in the development of the Regional Plan to reduce fumes from diesel engines to the extent possible.*"[9]

Type of Standard – Policy Statement

Evaluation Criteria – This Policy Statement was evaluated by determining whether TRPA and other agencies have sufficiently adopted policies, ordinances, and programs in support of the Odor Threshold Policy Statement.

Attainment Status – The Odor Threshold Standard was determined to be implemented. A review of the current adopted policies, ordinances, and rules of TRPA, state and federal agencies has found support of the Policy Statement. These agencies have adopted policies and measures that address diesel odor, and there is evidence that the associated regulatory measures are effective in reducing diesel fuel emissions at Regional, state and national scales.

1. TRPA Policies, ordinances, and programs: Support for attainment of this Policy Statement is comprised of adopted policies and ordinances. This policy is a component of transportation control measures in the *Regional Transportation Plan*, and *"…limits vehicle idling in the Region."*[10] More specifically, this policy refers to components adopted in the *Code of Ordinances* – Chapter 91, which addresses vehicle idling restrictions, exemptions, and compliance programs. The relevant code is cited below. These ordinances are implemented at the project scale through the project review process.

   91.7 Idling Restrictions: A program to control extended vehicle idling is a Reasonably Available Control Technology in the Clean Air Acts of 1977, and is a contingency measure in the 1992 Air Quality Plan for the Lake Tahoe Basin.

   91.7A Duration: No person shall control a combustion engine in a parked auto, bus, or boat to idle for more than 30 consecutive minutes in the following Plan Areas: 070A, 080, 089A, 089B, 090, 091, and 092. The following projects and activities are not subject to this limitation:

   (1) Activities specifically permitted, after environmental impact analysis, to idle more than 30 minutes
   (2) Emergency vehicles, snowplows, or combustion engines required in the case of emergencies or repair
   (3) Vehicles in transit on public rights of way

   91.7B Drive-Up Windows: New drive-up windows are prohibited.

[9] *TRPA Resolution 82-11*
[10] *Transportation Control Measures of the Regional Transportation Plan*

91.7C <u>Compliance Program:</u> TRPA shall implement the provisions of Subsection 91.7.A primarily through educational programs, notification programs, and cooperative arrangements with charter operators, property owners in the affected plan areas, and local government. As appropriate, TRPA may take direct action to obtain compliance with this section, including, but not limited to, actions under Chapter 8 and 9 of the Code.

According to the adopted ordinance found in the *Code of Ordinances*, a compliance program addressing the idling restriction shall be implemented *"…primarily through educational programs, notification programs, and cooperative arrangements with charter operators, property owners in the affected plan areas, and local government."* According to TRPA's Transportation Department, the agency continuously works with local public transportation providers to fund and support the purchase of alternative fuel buses in support of this ordinance. Because of more stringent state and federal policies and tail-pipe emission standard, and ordinances and programs that reduce diesel emissions, it was found that TRPA should focus on this type of policy support, instead of focusing on specific education and outreach programs.

2. Effectiveness of implemented agency, state and federal policies: There are currently no monitoring efforts underway that could be used to assess the effectiveness of implemented TRPA policies and ordinances on diesel emissions. However, stringent state and federal measures and programs have been shown to be effective in reducing odor emissions.

State and Federal Odor Reduction Measures- Adopted in 1988, California diesel fuel regulations set limits on aromatic hydrocarbon content (10 percent by volume) and on sulfur content (500 parts per million by weight, ppmw). These regulations, in effect since 1993, reduce emissions from diesel engines and equipment as follows (Greenlinks 2011):

- 7 percent less Oxides of Nitrogen (NOx)
- 25 percent less Particulate Matter (PM)
- 80 percent less Sulfur Oxides (SO_2), and several other toxic substances, such as benzene and Polynuclear Aromatic Hydrocarbons (PAHs)

The California Air Resources Board (CARB) and the United States Environmental Protection Agency (U.S. EPA) implemented a stricter "low sulfur" diesel fuel restriction, requiring a sulfur level of 15 ppmw or less beginning in 2007 (phase-in schedule 2007-2010). The CARB is also responsible for an anti-idling rule, specifically applying to drivers of diesel-fueled commercial vehicles with a gross weight rating of more than 10,000 lbs. The anti-idling rule imposes a 5-minute idling limit for these vehicles at any location in California (Greenlinks 2011). Lastly, the rule requires all 2008 and newer model-year diesel engines *"…either be equipped with a non-programmable automatic engine shutdown system that shuts the idling engine down after a minimum period of time or must be certified to a NOx idling emission standard of 30 grams per hour"* (CARB2011b). Exceptions to these idling restrictions include school buses, recreational vehicles, and military vehicles.

The following odor reduction measures have been implemented specifically by CARB (Greenlinks 2011):

CARB Specific Diesel Emission Reduction Measures

The identification of diesel particulate matter (PM) as a toxic air contaminant in 1998 led the California Air Resources Board (CARB) to adopt the Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles (Plan) in September 2000. The Plan's goals are a 75 percent reduction in diesel PM by 2010 and an 85 percent reduction by 2020 from the 2000 baseline.

Fleet Rule for Transit Agencies (adopted 2000): *This regulation cuts NOx and PM emissions from approximately 10,000 buses operated by transit agencies. The fleet rule for transit agencies moves forward in steps over 10 years, requiring cleaner engines, cleaner fuel, and retrofitting of older buses. Amendments proposed for 2004 will require transit agencies to clean up the buses that had not been covered in the original rule.*

School Bus Idling Restrictions (adopted 2002): *To reduce the exposure of children to toxic PM emissions, CARB enacted a rule to stop the prolonged idling of diesel school buses and other diesel vehicles near schools. Buses and commercial diesel vehicles are required to turn off their engines after arriving at a school, and are allowed to start the engine no more than 30 seconds before departing, unless required for safety or work.*

Stationary Engines (adopted 2004): *There are approximately 26,000 stationary diesel-fueled engines in California. Most are used as emergency backup in the event of a power failure. Others are used to pump water in agricultural areas, to run compressors, cranes and other equipment. New CARB standards for these engines will bring an approximate 80 percent PM reduction by 2020 through stricter standards for new engines and requirements to retrofit existing engines.*

Transport Refrigeration Units (adopted 2004): *Transport Refrigeration Units (TRUs) are diesel-powered refrigeration units that cool temperature-sensitive products while they are being shipped in trucks, trailers, shipping containers and rail cars. Although the diesel engines powering TRUs tend to be relatively small, there are about 40,000 of them operating in California. Their PM emissions will be reduced by 65 percent by 2010 and by 92 percent by 2020.*

In addition to regulations and standards for diesel engine emissions, the U.S. EPA has developed assistance programs that award funding for clean diesel projects and technologies. As part of the Energy Policy Act of 2005, the Diesel Emissions Reduction Act (DERA) authorizes funding of up to $200 million annually to help fleet owners reduce diesel emissions (EPA 2011f).

Additional Reductions Attributed to State and Federal Measures – As a result of the "low sulfur" diesel fuel restriction implemented in 2007, which required a diesel fuel sulfur level of 15 ppmw or less, refiners began producing cleaner burning fuels beginning in 2006. The EPA estimates that 2.6 million tons of smog-causing nitrogen oxide emissions will be reduced each year (EPA 2011d), with particulate matter being reduced by 110,000 tons a year (EPA 2011f). In addition, this diesel fuel requirement substantially decreases negative health effects associated from these harmful emissions. According to the U.S. EPA, *"…an estimated 8,300 premature deaths, 5,500 cases of chronic bronchitis and 17,600 cases of acute bronchitis in children will be prevented annually," (EPA 2011d)* with an additionally estimated "...*360,000 asthma attacks and 386,000 cases of respiratory symptoms in asthmatic children also avoided every year.*"

Interim Target – The Policy Statement has been implemented in the *Regional Plan* and by other agencies with authority to regulate diesel emissions, and thus, an interim target is not required.

Target Attainment Date – The Policy Statement has been implemented in the *Regional Plan* and by other agencies with authority to regulated diesel emissions, and thus, a target attainment date is not required.

Recommendation for Additional Actions – Resolution 82-11 intended that Policy Statements be incorporated into the *Regional Plan*. This evaluation demonstrates that TRPA and other agencies have incorporated and supported the Policy Statement. Consequently, it is recommended that this Policy Statement be removed from the list of adopted Threshold Standards in Resolution 82-11, or translated into a Numerical Standard for which an objective determination of status can be determined. For example, the TRPA could instead use applicable ambient air quality standards (for NO_x, SO_2, CO, PM) that are directly related to diesel engine emissions to measure attainment with the diesel odor standard. Based on current TRPA and state and federal actions, it appears that state and federal measures and programs have been effective in reducing odor. In addition, state and federal actions, in conjunction with adopted TRPA policies, appear to be sufficient in lieu of TRPA program support. The TRPA should continue working with state and local air quality management agencies in determining the status of air pollutants in the Basin.